New York State Education Department

NEW YORK STATE MUSEUM

62d ANNUAL REPORT

1908

In 4 volumes

VOLUME 1

REPORT OF THE DIRECTOR 1908

AND

APPENDIXES 1, 2

TRANSMITTED TO THE LEGISLATURE MARCH 15, 1909

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1909

STATE OF NEW YORK

No. 64

IN ASSEMBLY

MARCH 15, 1909

62d ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

VOLUME 1

To the Legislature of the State of New York

We have the honor to submit herewith, pursuant to law, as the 62d Annual Report of the New York State Museum, the report of the Director, including the reports of the State Geologist and State Paleontologist, and the reports of the State Entomologist and the State Botanist, with appendixes.

ST CLAIR MCKELWAY
Vice Chancellor of the University

ANDREW S. DRAPER
Commissioner of Education

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Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 453 ALBANY, N. Y. AUGUST 15, 1909

New York State Museum

JOHN M. CLARKE, Director

Museum bulletin 133

FIFTH REPORT OF THE DIRECTOR OF THE SCIENCE DIVISION

INCLUDING THE

62D REPORT OF THE STATE MUSEUM, THE 28TH REPORT OF THE STATE GEOLOGIST, AND THE REPORT OF THE STATE PALEONTOLOGIST FOR 1908

New York State Education Department
Science Division, February 8, 1909

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to communicate herewith the annual report of the Director of the Science Division and recommend its publication in the usual form, as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 9th day of February 1909

A. S. Draper

Commissioner of Education

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DIRECTOR'S REPORT FOR 1908

INTRODUCTION

This report covers all departments of scientific work under the charge of the Education Department and the Regents of the University and concerns the progress made therein during the fiscal year 1907–8. It constitutes the 62d annual report of the State Museum and is introductory to all the scientific memoirs, bulletins and other publications issued from this office during the year mentioned.

Under the action of the Regents of the University (April 26, 1904) the work of the Science Division is "under the immediate supervision of the Commissioner of Education," and the advisory committee of the Board of Regents of the University having the affairs of this division in charge are the Honorables: T. Guilford Smith LL.D., Buffalo; Daniel Beach LL.D., Watkins; Lucian L. Shedden LL.D., Plattsburg.

The subjects to be presented in this report are considered under the following chapters:

I Condition of the scientific collections

II Report on the Geological Survey, including the work of the State Geologist and Paleontologist, of the Mineralogist and that in Industrial Geology

III Report of the State Botanist

IV Report of the State Entomologist

V Report on the Zoology section

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I

CONDITION OF THE SCIENTIFIC COLLECTIONS CONSTITUTING THE STATE MUSEUM

In my report of the past two years full statements have been made concerning the general condition of the collections which, from force of circumstances, have undergone no change during the current year except in the increase shown by the list of accessions given on succeeding pages. For these accessions, which excellently serve to indicate the public interest in the museum as well as the assiduity of its staff, provision can be made only by removal of other collections into storage.

II

REPORT ON THE GEOLOGICAL SURVEY INCLUDING THE WORK OF THE STATE GEOLOGIST AND PALEONTOLOGIST, OF THE MINERALOGIST AND THAT IN INDUSTRIAL GEOLOGY

GEOLOGICAL SURVEY

Areal rock geology

Operations directed toward the execution of a geological map on the topographic base of 1 mile to the inch have continued along lines which have been followed for several years.

Central and western New York. Reports completed and awaiting publication cover the areal geology of the following quadrangles: Syracuse, Morrisville, Cazenovia, Auburn-Genoa, Honeoye-Wayland (these to be produced as double sheets) and Phelps. Field work has been completed by Mr Luther for the Caledonia quadrangle and progress made on the Batavia and Attica sheets; by Mr Whitnall on the Chittenango sheet and by Prof. W. J. Miller on the Port Leyden sheet. The report on the Remsen quadrangle has been completed by Professor Miller and is now in press.

All the foregoing maps, except the last two, are of regions where the rocks are unaltered Paleozoic sediments and the problems involved are those of exact classification and distribution of these deposits. The Remsen region is largely composed of such formations but also embraces an area of crystalline rocks, while the Port Leyden area is chiefly covered by crystallines.

Northern New York. The area of active operation in this region embraced the district west and southwest of the Adirondacks and a portion of the Lake Champlain territory on the east of the mountains.

In my last report reference was made to the work of Prof. H. P. Cushing upon the Theresa and Alexandria Bay quadrangles. This has been brought to completion and the survey extended to include the Grindstone, Clayton and Cape Vincent quadrangles. With collaboration of Prof. C. H. Smyth jr and Dr Ruedemann the field work for the entire five quadrangles was closed and the report on the work is in course of preparation. Dr Ruedemann mapped the St Vincent and southern half of the Clayton quadrangles and Professor Smyth gave most of his attention to the somewhat complicated crystalline geology of Wellesley island while Professor Cushing mapped the rest of the areas specified. The problems involved in this region are significant and have required cautious work both in the sedimentaries and the crystallines. The Paleozoic rocks here present members not elsewhere represented in New York and the actual relations of these sedimentary formations to those on the east and southeast of the Adirondack area are not as yet entirely clear. Much assistance in this work was derived from consultation with Dr H. M. Ami of the Geological Survey of Canada and E. O. Ulrich of the United States Geological Survey, both of whom spent some time in this field.

The chief purpose in extending the area of these operations was to determine with accuracy the distribution and magnitude of the

Pamelia (Stones river) formation in the region. It was found to extend across the Clayton quadrangle with increasing thickness and into Canada in much greater force than could have been inferred. About Kingston it has much the same thickness as in the Clayton region and it probably runs from there westward all the way across Ontario as the basal member of the Paleozoic series of that district. It also extends up the Black river valley in greater thickness than could have been anticipated from any published descriptions of the region. Detailed field work has definitely determined an unconformity between it and the overlying Lowville limestone.

The Paleozoic rocks of the district display a series of low folds in two directions, one trending northeast and another of later date and minor amount trending northwest and folding the earlier folds, producing domes at intersections of the arches of the two sets and shallow basins at trough intersections.

It is specially noticeable in the southern half of the Clayton area that the dip of the rocks and the direction of the drainage coincide. Wherever the gradient of the streams becomes steeper than the dip, there has resulted a local downcutting which brings to light the lower strata in patches entirely inclosed by the higher; illustrated particularly by the exposure of irregular patches along active or abandoned stream channels, of the Lowville limestone in the midst of a blanket of the Black River limestone. Dr Ruedemann who has studied and plotted these areas regards them as of identical character with the "Fenster" of the German geologists, windows out of which look the lower formations. As an English term of equivalence he proposes the expression *erosion inliers* as distinguished from the more usual depositional inliers which are of tectonic origin. Besides these erosion inliers the same area also exhibits patches of the Lowville beds exposed in the mantle of overlying Black River limestone by solution of the latter along joint planes making *solution inliers*. Though these are usually of small area yet some are large enough to record on the topographic base. Another erosional phenomenon of interest better exhibited on the Clayton sheet than elsewhere in the State is expressed by long tongues of Black River beds capping narrow ridges that project northward in groups from the Black River zone. The ridges in each group are of subequal width and parallel to each other. They are believed by Dr Ruedemann to have originated from the plucking action of the glacial ice along joint planes and their main direction is consequently parallel to the direction of the principal joints in each locality and to the movement of the ice.

The Precambric rocks of the district comprise old sediments of Grenville age and various igneous rocks of later age which have freely cut the Grenville schists. The latter show a thickness of several thousand feet, the greater part comprised in a series of rocks of varied nature within which are thin bands of white limestone and of quartzite, with much impure limestone. Unless the series has been overturned the limestone is at the bottom and the heavier quartzite at the top. The oldest of the igneous rocks is the Laurentian granite gneiss, two considerable bathylithic sheets of which lie in part in the mapped area and have been designated the Antwerp and the Alexandria bathyliths. The gneiss is full of inclusions of the Grenville rocks and clearly shows that it has absorbed large quantities of the Grenville, with the production of certain mixed rocks.

The Grenville limestone has had a singular bleaching effect on the red granite gneiss, turning it white. All the granite dikes that cut the limestone are white and the edges of the larger masses have the same color in the vicinity of the limestone; in fact the color change in the granite is an infallible indication of approach to the limestone, as repeatedly tested and proved in the field.

An analogous change is observable at granite-quartzite contacts, the granite becoming more acid, tending to bleach and showing much more frequent joints. Over the area mapped the granite gneisses seem to have been deficient in mineralizing fluids and have not notably altered the Grenville rocks, the granite showing more noticeable contact effects than the sediments.

The later igneous rocks comprise a small streak of syenite, one of diorite, a very small one of gabbro and a fairly large mass of coarse red granite, the Picton granite, which seems to be the latest of all, has a considerable extent of outcrop on Grindstone and Wellesley islands and a much wider extent across the border in Canada, though on the New York side it makes little show except for an abundance of dikes which cut all the other rocks. On the islands the granite is full of inclusions of the other rocks and on Wellesley they are remarkably abundant, have retained their original orientation, their strikes and dips being uniform and concordant with those of the main areas of the rocks away from the granite, so that they can be mapped into belts of quartzite, amphibolites and granite gneiss with as much exactitude as though the later granite were not present. This is taken to imply that here the very roof of this portion of the bathylith is now at the surface, the in-

clusions representing those parts last torn away from the cover formerly overlying the granite which was then in such viscous condition that the inclusions have moved but little from their point of detachment. Unlike the granite gneiss, this Picton granite was well supplied with mineralizing agents and has produced considerable contact effect on the adjacent rocks, notably a striking development of tourmalin.

There is also a considerable development of wide trap dikes on Grindstone and Wellesley islands from which an abundant and cheap supply of the very best road rock can be readily obtained.

Eastern Adirondacks. The mapping of the Elizabethtown-Port Henry quadrangles is reported by Professor Kemp as practically complete and the manuscript of the bulletin prepared. This is a complicated region including the extensive iron bodies of Mineville and vicinity and has required repeated review. An exposition of the Mineville mines and ores prepared by Professor Kemp has been published during the year as a special part of Bulletin 119, *Geology of the Adirondack Magnetic Iron Ores.* The regions referred to carry, along the shore of Lake Champlain, an interesting display of the Paleozoic formations which have been specially reviewed by Dr Ruedemann who has found that the Paleozoic areas which are of semioval or semielliptic shape, opening toward the lake and suggesting embayments, consist of groups of small fault blocks bounded on the west by northeasterly master faults and broken up again by transverse faults at various angles to the former. The small blocks may dip in various directions but hold a prevailing dip away from the mountains or toward the east. The work on the Ausable and Westport quadrangles has progressed. The geology involved herein is similar to that on the Elizabethtown and Port Henry sheets and with the adjustment of the latter, the other work will lend itself to readier solution.

Southeastern New York. *Geology of the Hudson Highlands and cooperation with the New York City Board of Water Supply.* An agreement entered into in the past year by the chief engineer of the Board of Water Supply of New York City and the State Geologist gives to the latter access to the highly important records of deep seated geologic structure from the southern Catskills southward to the mouth of the Hudson, acquired in the course of the remarkable engineering undertaking with which that board is concerned. By innumerable deep borings on both sides of the Hudson river and through its bed, in a region where the geology is highly complex, the operations of the board's engineers have

assembled a body of data of extraordinary importance bearing upon the physiography and geological structure of the lower Hudson valley and the adjoining region. Two years ago the areal survey of the Highlands quadrangles was placed in charge of Dr Charles P. Berkey who has also become associated as geologist with the Board of Water Supply. This double professional interest enables Dr Berkey to assemble and combine all the data most effectively. During the past season more time was spent upon structural and petrographic details of this work than on a continuance of areal mapping, as this was made necessary from the accumulation of drill records and similar data. It is of interest to note that these deep seated data do not intimate any inaccuracy in the determination from the surface, of the stratigraphic succession or of general interpretation. On the contrary these well established factors were a constant guide to the engineering exploration and to the interpretation of data gathered throughout the work. But the data available are so abundant and well distributed as to enable the construction of cross sections with exceptional accuracy. The preliminary explorations of the Catskill Aqueduct are largely finished. More complete data, such as may be gathered as the tunnels progress will not be obtainable for several years and it therefore seems advisable to arrange the present matter for immediate use. This is being done in the form of a bulletin which will present an outline of the geology of southeastern New York as now understood, and a discussion of the significance of the newer factors.

In further areal work in the Highlands additional limestone occurrences have been noted some of which at least are clearly interbedded or included in the gneisses. These interbedded limestones (probably of Grenville age) are now known in the Highlands proper at occasional points from the vicinity of Brewster near the Connecticut line to Tuxedo lake near the New Jersey line, but they appear to be most frequent in the central or Hudson River belt. An important connecting link between the gneisses of New York city and of the Highlands proper was found in the discovery of interbedded limestones in the city at the type locality of the Fordham gneiss. Three points were found near Jerome Park reservoir in the Borough of the Bronx where the limestones are surely of this interbedded relation. In two of them the structural relations are unusually clear. They are small beds but lie within small anticlinal folds in such a way as wholly to preclude the possibility of infolding of overlying strata. In all cases these

oldest limestones are very impure. At Jerome Park reservoir they carry an abundance of chondrodite and many unusual minerals, such as actinolite, sphalerite and galenite.

It is fairly certain that the gneiss series in southwestern New York can best be regarded as a unit formation, the basis of which is a metamorphosed sediment into which are intruded in a highly complex manner igneous masses of various kinds and sometimes of so large amount as to wholly obscure the original type. In some localities these igneous masses largely predominate and may merit local names but in all cases seen they give evidence of being distinctly younger than the associated recrystallized sediments.

An additional complexity has been observed in the vicinity of Brewster in the Carmel quadrangle on the southeast margin of the Highlands. Several narrow but remarkably continuous strips of limestone occur in the schist. The most reasonable explanation of them is that they are interbedded with the Manhattan schist. All of the crystalline formations have been traced to the State line in this vicinity, crossing the border into both Danbury and Ridgefield, Conn. In comparing the formations of the New York side, which have been followed in this investigation continuously from their type localities in New York city, with the new (1906) areal geologic map of Connecticut, the following points of correlation are established:

1 Two belts of crystalline limestone known on the New York side as *Inwood* limestone continue into Connecticut, the one into Danbury and the other into Ridgefield, as "Stockbridge" limestone.

2 Two belts of older gneisses, considered on the New York side as equivalent to the *Fordham* gneiss, continue into Connecticut as the "Becket" gneiss.

3 One belt of schist, somewhat more complex than usual by reason of intrusions, known as *Manhattan* schist on the New York side, continues into Ridgefield, Conn. but on the Connecticut map is not differentiated from the "Becket" gneiss.

In the Poughkeepsie quadrangle the work of areal survey has been carried on by Prof. C. E. Gordon. This quadrangle embraces a portion of the Highlands of southeastern New York, known generally as the Fishkill mountains, which on the north are overlapped by and faulted with the lower Paleozoics which extend northward in the Hudson valley. Frequently the Highland mass has overridden the newer strata and presents today many anomalous relationships with the latter. From these clearly marked and

extensive fault and thrust movements we may infer the existence of similar ones to the south and east which may serve to explain some of the difficult phenomena there exhibited, in the presence, or absence, or metamorphism of the younger rocks and in the intrarelationships among the basal gneisses.

Thrust movements of considerable magnitude, measured by hundreds or a few thousand feet, are occasional and numerous smaller adjustment faults are frequent. No evidence has been secured of displacements on the west of the Highlands axis which are supposed to have carried the strata for distances of miles; and were the strata that once overlay this region to be restored it is probable that the extent of overturning and overthrusting could be measured by a few thousand feet.

The present altitude of the Highlands with respect to the neighboring Paleozoics serves in general as no indication of the former early relations between these great rock divisions. Folding, faulting and erosion, each or all, perhaps, repeated, have combined to efface the original early relationship. We seize upon what time has left with the hope of untangling the maze that now confronts us.

The sky-line of the summits of the Highlands knobs and ridges even with that of more distant hills among the younger rocks presents the aspect of a former base level that is unmistakable. What masses of overlying strata have been removed from these crystalline Highlands rocks we can only guess from the thickness of those to the northward, the character of the folding there, and the length of time the region has suffered denudation. Lofty mountain ridges were reduced from alpine hights to a peneplain. From their stumps we are obliged to construct our imperfect history of the region.

Perhaps in no other place in eastern North America is the contact of the lowest Paleozoics on the underlying Precambric better preserved than on the flanks of the Highlands of southeastern New York and nowhere is it better shown than on the northern slope of the Fishkill mountains.

Here for considerable distances the basal Cambric quartzite rests unconformably upon the folded basal gneisses. The forces of erosion that have removed the quartzite and the overlying limestones, which once filled the northern valleys of these mountains, have cut deeply enough to expose a faulted block of the basal Paleozoics where the relationships have been well preserved. The usual abnormal relationships present along this border as a result

of thrust faulting are here absent. In many places the close proximity of folded gneiss and overlying quartzite show the great discordance in the dip of the two and less distinctly, though plainly, in that of the strike. In places the two are so near that for all practical purposes we are dealing with the actual contacts. The relationship presents the aspect of an overlapping sea. Leaving the gneisses at the south, one successively passes over the quartzite and overlying limestones northward until lost in the close folding there prevailing. Erosion has greatly trenched the comparatively soluble limestones of the Fishkill belt and has planed these strata down nearly to a common level across the faults and folds. The confusion resulting does not conceal the substantial thickness of the limestone strata and the great thickness of the slates and schists of the Hudson valley to the northward only strengthens the conviction that they, with the limestones, once covered the tops and filled the valleys of the Highlands over which they were carried by an overlapping sea that progressively advanced over a subsiding Precambric land mass.

It is proposed in the later report to discuss in this connection the occurrence of scattered masses of the younger rocks met with in the Highlands and to suggest explanations for these occurrences. It is purposed, also, to discuss the significance of the great block fault south of the Highlands, which has dropped the younger rocks of southeastern New York and the shattering which the Highlands mass received from the forces producing this and other faults. Some treatment will necessarily be given to the proposition that a combination of forces, acting as a gigantic couple, the resultant of the westward tangential pressures operated with the Adirondack Precambric buttress to induce strike and transverse faulting of an exceptionally violent sort in the powerfully elastic rocks of the Hudson valley.

Highlands of the quadrangle. The general petrography and stratigraphy point to a Precambric sedimentary series with a Precambric intrusive sill, or bathylith, and some apparently later intrusions. The discovery of an altered limestone interbedded with the gneisses, the heterogeneous character of the gneisses themselves and the occurrence of repetitions within them of certain rock types, as well as, apparently, some plainer evidence of bedding, are taken as the principal evidences of a sedimentary origin. Microscopic evidence will be presented. No graphitic strata have been noted. The structural features belong both to Precambric and later time. Later deformations have been superimposed on earlier

ones during the later period of mountain making. In the town of Fishkill, lying within the younger rocks and extending from near the base of the Bald Hill spur northeastward for a distance of 5 miles and terminating in a faulted block known as " Fly mountain," is a narrow inlier of Precambric rocks which will be shown to be a part of the Highlands.

Reconnaissance through the Highlands indicates the essential similarity between the basal gneisses of this quadrangle and the rest of the northern Highlands. Within the quadrangle there is no evidence of more than one sedimentary series. Considerable shearing has occurred and is considered responsible for some of the foliation. Later faulting and shearing have obscured earlier features. There is given as a result of pressure always applied in the same general direction and from the factors just mentioned an isoclinal character to these rocks that simulates an immense monoclinal series of sediments. Continuity has been broken, and repetitions by earlier folding have been sheared out, by faulting. If the identification of the stratum of serpentinous rock, interbedded with the gneiss, as an altered limestone be correct, the general resemblance which these gneisses have to the other basal gneisses of the Highlands has confirmation in that fact. Recent work by Berkey[1] in Manhattan shows limestones interbedded with the Fordham gneiss, which strengthen the correlation previously made by him of the Fordham gneiss with the gneisses of the Highlands.

Poughquag quartzite. This formation which intermittently appears, overlying the gneisses along their northern border, from the type locality at Poughquag, Dutchess co., to the Hudson river is undoubtedly of Lower Cambric age. Fossils have not been found in this formation, but the blue limestone immediately overlying it, into which it grades, has yielded the opercula of Hyolithellus micans. The relationship of the quartzite to the gneiss and of the quartzite to the overlying limestones and calcareous shales as seen south of Johnsville, in the East Hook, are very similar to those near Stissing mountain, at Stissing Junction and Attlebury, farther north in Dutchess county, which have been proved to be Lower Cambric by the discovery of Olenellus in the quartzite and of opercula of H. micans in the overlying limestone. The rusty friable Olenellus quartzite described by Walcott and Dwight and found by the writer west of Stissing Junction could not be located in the Fishkill mountains.

[1] Science N. S. v. 28, no. 730, p. 936.

A small patch of the basal quartzite was found resting on the granite gneiss at Fly mountain, evidently faulted with it. It was also found reposing on a small inlier of these rocks outcropping between the base of the Bald Hill spur and the southern extremity of the Glenham gneiss belt, in the town of Matteawan. These facts afford additional evidence of the age of the rocks of the Glenham belt.

Fishkill limestone. This belt of Cambro-Ordovicic limestone as displayed within the quadrangle has yielded fossil evidence of its age despite the metamorphism it has undergone. In the Hook district south of Johnsville, where the strata have been preserved in more nearly their original relationship, I have found the scanty but conclusive evidence of the age of the blue, compact limestone overlying the hard, compact quartzite in the presence of well preserved opercula of Hyolithellus micans. In the town of Fishkill, northwest of the road from Fishkill Village to Matteawan, between it and the Glenham gneiss belt, and extending a couple of miles roughly paralled with the outcrop of the latter, I have traced a belt of hard limestone weathering grayish white, but showing buff-colored markings on fresh surfaces, with weathered surfaces showing among the lichens the closely compacted whorls of what I believe to be Ophileta compacta Salter. The belt can not be traced beyond the road from Fishkill Village to Wappingers Falls. Faults and metamorphism have greatly obscured, if they have not obliterated it. In the limestone at Old Hopewell, near the old furnace, and just north of Gregory's gristmill, I have found fragments of Orthoceras and one complete specimen, as yet unidentified, weathered out on the surfaces of a gray, banded crystalline limestone, very close to marble in the degree of metamorphism which it shows.

We have evidence of the presence of the lowest Cambric and the lowest Ordovicic in this limestone belt, by the discovery for the first time, of actual fossils. In the final report other less certainly defined but important details may more pertinently be discussed.

Wappinger limestone (Barnegate limestone, Mather). In this belt, first called the "Barnegate limestone," by Mather, but because of the association which the Wappinger creek has with it for many miles, now more commonly called the "Wappinger limestone," additional confirmatory discoveries have been made which extend somewhat the boundaries of certain terranes within

it. In two old, abandoned quarries on the farm of Mr Byer, near Manchester Bridge, 3 miles east of Poughkeepsie, the Trenton conglomerate, so well displayed at Pleasant Valley and Rockdale, was found filled with Solenopora compacta and crinoid stems, and overlain by hard, blue, medium bedded limestones carrying a rather full assemblage of brachiopods, with an occasional trilobite, all of apparent Trenton affinities. Southeast of Poughkeepsie on the Spackenkill road, on the farm of Mr Ruppert, in a quarry being worked for lime, in a hard, thick-bedded limestone, coils resembling gastropods and a Hyolithellus were discovered and above these in the somewhat thinner beds in the upper part of the quarry, Lingulepis pinniformis and a trilobite probably Ptychoparia, thus confirming the occurrence and abundance of the Potsdam fauna as first discovered by Dwight nearer Poughkeepsie, 2 miles north of this quarry. The now known localities of Potsdam fossils within this quadrangle and the thickness of the strata show it to be a prominently developed terrane.

Numerous smaller patches of limestone, or limestone conglomerate, occurring as inliers in the slates to the east of Wappinger creek have been noted and mapped, but can not be discussed here and may be left for the fuller report.

Slates. The Paleozoic rocks of this quadrangle present a complicated structural and stratigraphic problem. The structural features and many details can not be more than alluded to in this report.

Recalling the faulted proximity which Lower Cambric rocks have to those of Ordovicic age at the north, as at Bald mountain, Washington co., the slates and schists in the eastern part of the quadrangle were studied for such relationships. The small limestone inliers were examined in this connection. The possibility of the Normanskill and the Utica occurring in the western slates was considered; but no evidence of any of these was secured. Fossils were hard to find. In the slates they were noted at many of the localities where previously discovered, but were not seen at others. The general relationships suggested nothing older than the Trenton limestone of the region. Only one new fossil locality was discovered in the slates. At Swartoutville, 2 miles north of Brinckerhoff, between Fishkill Village and Hopewell Junction in fissile, broken slates, along a fault between them and the barren northwest margin of the Fishkill limestone, brachiopod fragments were discovered. Their examination has only suggested a horizon of Trenton or later age.

The slates present many lithologic variations and many interesting stratigraphic and structural relations which can not be given here.

Metamorphism. In this report the general fact of greater metamorphism of the Paleozoics to the east should be noted. Reconnaissance in Dutchess county reveals that the metamorphism of these rocks is a function of the distance of these strata from the Hudson river in the northern portion of the county. At the south apparently the increment by which metamorphism approaches a given degree is greater per unit distance, and apparently is in some way related to the proximity of the Highlands mass.

The map and complete presentation of details and conclusions are reserved for a later and fuller report on the geology of the Poughkeepsie quadrangle.

Surficial geology

The examination of the glacial and postglacial deposits and their interpretation in terms of the agents performing the work has been continued during the past season by Prof. H. L. Fairchild in the region about the east end of Lake Ontario, especially in the area covered by the Grindstone, Alexandria Bay, Cape Vincent, Clayton and Theresa quadrangles. The glacial and glaciolacustrine features are striking and peculiar; over all the area the deposits were laid down under the deep waters of Lake Iroquois and the north and east portions of the area were also covered by the marine waters of Gilbert gulf. In the lowering of these waters all the land surfaces were wave swept and in consequence the drift is mostly gathered into the depressions. The two striking drift features are the extensive clay plains which occupy the valleys and the lower tracts and the few boulder moraines. The drift sheet as a whole is scanty and many extensive tracts are essentially bare rock. The striking physiographic features are the hummocks or rock knobs in the districts of crystalline rocks, the broad plains produced by the sedimentaries and the clay plains of the lowlands and valleys.

Suggestions are found of a Prewisconsin glaciation, though no interglacial or warm climate deposits are yet determined. Over large tracts of the limestone the surface has been worn into broad furrows and ridges, a huge " washboard " structure which has lost its original glacial polish and striae. A later ice abrasion has cut these parallel ridges usually at a considerable angle. The old planation surfaces have lost much of their glacial character. In

the central and eastern parts of the State two sheets of till are indicated, one superimposed on the other. The indications are that the later ice invasion was very weak.

The southward overflow of the ice-impounded waters held in the Black river valley built high and broad deltas in the vicinity of Trenton and Trenton Falls, and later north of Rome. During the time of this overflow and earlier, glacial waters were also held in the Mohawk valley much above the Iroquois level, and on the west and south flanks of the Adirondacks above the Black river waters. The existence of these high waters has been found to be due to the ice blockade of the Mohawk valley. As the Labradoran ice sheet waned and the Adirondack rock surface was exposed the Ontarian ice lobe pushed eastward into the upper Mohawk valley while the Hudson river lobe pushed westward up the same valley. At an early stage of this opposing flow through the Mohawk valley the westward flow of the Hudson lobe prevailed and excellent drumlins were formed by westward moving ice, as far as Cedarville, 12 miles southeast of Utica. Professor Brigham has reported the presence of west pointing drumlins in the Johnstown district.

It is quite possible that the earliest waters which gathered in the valleys of the Adirondacks found escape across the Mohawk glacier to Susquehanna drainage. Certainly there came a time when an open lake was held in the Mohawk valley between the two opposing ice lobes. The earliest overflow of this Mohawk glacial lake seems to have been across the col 6 miles east of Richfield Springs and at the head of the Otsego valley, with present elevation of 1360 feet. The many broad delta plains at 1440 feet on the south flank of the Adirondacks correlates with this outlet when allowance is made for the postglacial deformation of the land. A lower escape of the Mohawk lake was found at Cedarville at the head of the Unadilla valley, with altitude 1220 feet. This pass correlates with the conspicuous sand plains at 1300 feet altitude. Possibly a still lower escape was found at Bouckville to the Chenango valley at 1160 feet. But soon the overflow was shifted to the eastward by the backing away of the ice front from the face of the Helderberg scarp, 10 miles southwest of Schenectady.

The Schoharie valley had held glacial waters (as shown by Professor Brigham in my last report) with earliest outlet by one or more of the three passes at the head of the basin, at 1920 feet. Later the Schoharie waters blended with the Mohawk waters with overflow by the outlets leading to Susquehanna drainage, as noted above. The pass at 1500 feet to the Schenevus valley never carried any flood. The pass south of Middleburg to the Catskill creek,

at 1200 feet, has a little swash channel across it, but was never cut by a river. The failure of flow across this col seems to be due to the Hudson ice flow blockading the Catskill valley.

When the ice front receded on the Helderberg scarp the Mohawk lake (including the Schoharie waters) found escape to the Hudson valley. The face of the Helderberg is strongly terraced by centuries of river work. This channeling continues southward along the west side of the Hudson valley where the rivers flowed alongside the ice tongue.

The lowest pass of this episode lies between Esperance and Delanson at 840 feet, now utilized by the Delaware and Hudson Railroad. This outlet correlates with numerous delta plains in the Mohawk valley, striking examples of which may be seen about Prospect and Trenton Falls, at 1100 to 900 feet.

The Delanson outlet was abandoned when the ice front weakened on the rock scarp west of Schenectady and at Rotterdam Junction. The blockade at this stage correlates with many plains in the upper Mohawk valley and with broad plains in the Sacandaga valley, already noted by Brigham. These have altitudes of 900 down to 700 feet.

The low altitude of the glacial waters in the upper Mohawk region forces us to the conclusion that the rock barrier at Little Falls must have been removed early in the history of the Postwisconsin drainage through the Mohawk valley, and long before it received the flood from the area of the Great Lakes. It appears to be more likely that the pass was chiefly cut by Prewisconsin drainage.

By the study of the several points of outflow of the glacial waters as indicated above, in comparison with their correlating sand plains reaching west to beyond Rome, it becomes possible to determine with some degree of exactness the limits of the two ice lobes (Ontario and Hudson) at certain critical stages of their waning. A series of large maps has been prepared to show in a general way the recession of the ice sheet over New York.

Industrial geology

Iron ores. The investigation of the State's iron ore fields — a work that has been under way for some time — was brought to partial completion during the past year by the publication of final reports upon the Adirondack magnetite district and the Clinton belt of hematite ores. These are the two largest fields and have the greatest commercial importance at present as well as for the

immediate future. It is intended eventually to continue the investigations so as to provide similar reports upon the other districts, thereby giving for the first time a comprehensive account of these deposits throughout the State. The subject of iron ore supplies is just now engaging unusual attention, due to the enormous growth recently in the consumption of iron and steel and a realization of the need of preparing to meet a correspondingly large advance in the years to come. With the increased demands made upon the mining fields, there has been a very appreciable falling off in the grade of the ores shipped to furnaces, a feature that is bringing new sources of supply within reach of practical utilization. A renewed interest is already manifest in both the Adirondacks and the Clinton district by the many developments that have taken place during the last year or so.

The Adirondack region has furnished altogether nearly 40,000,-000 tons of magnetite, mainly of high grade character. While important bodies of that kind still remain, sufficient to furnish an equivalent output at least in the future, the main resources consist of low grade ores, in which the magnetite is associated with gangue minerals and which require concentration before using in the furnace, and of the titaniferous magnetites hitherto held in little regard. Concentration is already being practised successfully on nontitaniferous ores carrying as low as 35% iron. There are numerous and large bodies of such ores awaiting development. In the report attention was called also to the possibility of utilizing the titaniferous magnetites, as some careful experiments have shown that the titanium can be partially removed by a process of concentration similar to the method employed for the other magnetites. Their amenability to concentration is dependent upon the fact that the titanium, in many cases at least, is mostly segregated as ilmenite, while the magnetite carries a subordinate amount only of that element. If concentration proves to be practicable on a commercial scale, there is no doubt that the deposits will come into immediate use, since the magnetites aside from their titanium content are admirably adapted to furnace use. It is understood that further tests along this line are in progress with reference to the Lake Sanford ore bodies which have recently been explored with highly satisfactory results.

The report on the Clinton ores includes a number of new sections showing the occurrence and stratigraphic relations of the ore seams over a portion of the belt hitherto unexplored. These sections were prepared from the records of drill holes put down during the fall

and winter of 1907–8 under a special appropriation for the purpose. The drill cores have been securely boxed and stored in the museum. As a result of the field investigations which have extended over every part of the Clinton formation in its extent from Herkimer county on the east to Niagara county on the west, the distribution of the ore seams has been ascertained in a general way with some definiteness. Though the seams are nearly everywhere present over the middle part of the belt, it is only in a relatively few areas that they are of size and character to have possible value for mining. The main resources are represented by the areas lying in Oneida, Cayuga and Wayne counties. Sufficient information is not yet at hand to afford a full and exact estimate of the quantity available, but a calculation based on seams above 18 inches thick and within 500 feet from the surface indicates that there is fully 600,000,000 tons of ore within these areas. With a total production of but 4,000,000 or 5,000,000 tons it is evident that the resources are capable of a much larger development than they have undergone up to the present time.

Mines and quarries. The annual bulletin presenting the developments and production statistics of all the mineral industries of the State was published in July, bringing the record down to the end of 1907. It is proposed to continue its issue, but for the current year the work of canvassing the industries will be carried out under cooperation with the United States Geological Survey. According to the plan adopted there is to be collected only a single set of returns, and the compilations will be made available for the uses of both offices.

MEMORANDUM OF AGREEMENT BETWEEN THE DIVISION OF MINERAL RESOURCES OF THE UNITED STATES GEOLOGICAL SURVEY AND THE STATISTICAL BRANCH OF THE NEW YORK STATE GEOLOGICAL SURVEY

In order to avoid a multiplicity of requests for statistical information for mine and quarry operations and also in order that the State Geologist may keep in touch with the mineral producers in the economic development of mineral resources of the State, the following agreement between the State Geologist and the Division of Mineral Resources of the United States Geological Survey is made:

Early in the fall of each year (by October 1st if possible) a list of the mineral producers in the State of New York, as the United States Geological Survey has them, is to be sent to the State Geologist who will check with the lists in the possession of the State

Survey and make such corrections as he may be able to from the State Survey records. These lists will then be returned to the Division of Mineral Resources of the United States Geological Survey.

Blanks for the collection of the statistics will be printed each year at the expense of the United States Geological Survey. Franked envelops for the transmission of the statistical blanks will be addressed in the office of the Federal Survey, and the blanks either numbered or having the name and address of the operator written thereon will be inclosed in these envelops with a circular letter from the Director of the Geological Survey. A franked envelop addressed to the State Geologist will be inclosed in the envelop with the circular letter and blanks and all will be sent unsealed to the State Geologist in order that he may inclose such additional circular to the operators as he may desire sent. By rubber stamp or otherwise the State Geologist will also indicate on the blank that the work is done by cooperation of the two surveys. On the return of the blanks to the State Geologist, he will have each report carefully scrutinized and see that it is in proper form for tabulation. He will make such transcript for his own uses as he may desire and then forward the reports to the United States Geological Survey. The second request for reports from producers who have not responded to the first inquiries will be prepared in the same manner in the office of the Federal Survey and transmitted to the State Geologist. If it is found advisable to send additional inquiries by mail the same plan will be followed except in the case of registering the letters, in which case they will have to be mailed from Washington. After the attempts to secure returns by mail have been exhausted the State Geologist will undertake to secure the reports from the delinquent operators by personal visits of himself or assistants.

In the publication of the statistical reports of the State Survey and of the United States Geological Survey, credit for the cooperative plan will be given.

John M. Clarke
State Geologist

E. W. Parker
Statistician in Charge,
Division of Mineral Resources,
United States Geological Survey

During the period in which the statistics have been collected, there has been a very satisfactory growth of the mineral industries of the State. The total output of all materials reported by the individual producers for 1907 was valued at $37,427,405. The corresponding values for previous years were: $37,132,832 in 1906; $35,470,987 in 1905 and $28,812,595 in 1904. The different items entering into the calculations number about 35 and include only the crude products or such as are in their first marketable forms.

SEISMOLOGICAL STATION

The Bosch-Omori instruments installed in the State Museum in March 1906 have given practically continuous service to the present time. Altogether they have furnished records of 35 different earthquakes, of which nine occurred during the year ending September 30, 1908. In the preceding year which seems to have been one of notable seismic activity, there were recorded 19 shocks. The remaining seven were registered in the period from March 10 to October 1, 1906.

The records obtained during the year just elapsed are listed in the accompanying table. When additional details relative to the individual disturbances have been available they are appended as notes. The character of the records varies to a marked degree, depending upon the wave motion set up by each shock, the distance of the focus and other factors not as yet well understood. Hence, it is not always possible to give the different elements characterizing a disturbance with satisfactory completeness, though in many cases, specially in respect to the more violent earthquakes, the records can be used as a reliable basis for deduction.

So far the instruments have recorded no earth movements of local origin. The sources of the disturbances have been widely distributed, but none of them nearer probably than 2000 miles. In a majority of instances, perhaps, they have been related to the series of readjustments that has taken place recently in the Cordilleran region of North and South America, as manifested by the extremely forceful earthquakes of San Francisco, Valparaiso and Central Mexico and a number of smaller ones within that zone. These seem to have been due to tectonic displacements or fault slips. With the relief of stress they have undoubtedly afforded, a period of comparative repose may be expected to follow and to continue for some time. The nearest region of disturbance to which local records can be definitely referred is the West Indies. There have been several shocks of notable size registered at Albany that could not be traced to any known occurrence on land and were probably of submarine origin.

The Albany station has communicated its observations from time to time to the International Seismological Association for record in its reports and to the California Earthquake Commission. The latter has recently published a comprehensive account of the San Francisco earthquake.

Full details of the local station have appeared in a previous report. The important constants applicable to the interpretation

of the records are as follows: latitude, n. 42° 39′ 6″; longitude, w. 73° 45′ 18″; hight above sea level, 85 feet; weight of each pendulum including arm 11.283 kilograms; distance of center of gravity from rotating axis, 84.6 centimeters; period of pendulums approximately 30 seconds; multiplying ratio 10. The machines have no artificial damping apparatus.

RECORD OF EARTHQUAKES AT ALBANY STATION, OCTOBER 1, 1907 TO OCTOBER 1, 1908

Standard time

DATE	Beginning preliminaries	Beginning principal part	Maximum	End	Max. amplitude
1907	h. m.	h. m.	h. m.	h. m.	mm.
Oct. 16	9 04 a. m.	9 15½	9 16	10 00	150
Oct. 20	11 36 p. m.	....	....	1 30	....
Dec. 30	12 32½ p. m.	12 43	12 45	1 30	70
1908					
Feb. 1	6 20 p. m.	6 32	....	7 30	....
Mar. 26	6 09½ p. m.	6 24	6 25	8 15	55
Mar. 26	10 53½ p. m.	11 08	....	12 00	5
May 15	3 47 a. m.	3 55	....	4 30	....
Aug. 13	7 55 p. m.	8 03	....	8 49	....
Sept. 21	2 01 a. m.	2 12	....	3 23	....

When the amplitude was less than 1 millimeter as a maximum, it has not been given.

October 16. A record of a microseism which appears to have been transmitted around the globe. It was reported by many of the foreign stations. Judging from the local tracing, the focus was approximately 5000 miles distant in a direction south of west, somewhere between the Hawaiian islands and the coast of Mexico. It was undoubtedly submarine. Slight shocks were reported from California on the same date.

October 20. Slight wave motion extending over a period of two hours. Also reported by the stations on the Isle of Wight and at Laibach, Austria. The focus seems to have been in central Asia, probably in Bokhara where several towns were badly shaken and damaged.

December 30. A severe disturbance, perhaps from the same zone as the earthquake of October 16. The origin is estimated

at 4000 miles from Albany. The shocks appear to have left no trace on land and can be assigned without much doubt to a submarine source.

February 1. Slight movements of unknown origin.

March 26. A record of the earthquake that occurred in the State of Guerrero, Mexico, and is reported to have destroyed Chilapa, a town 115 miles south of the City of Mexico. Two distinct series of vibrations were registered, beginning nearly five hours apart. The first was the more violent and represented the distinctive shocks. The records by both pendulums were of the same degree of magnitude. The indicated distance of the origin, according to the Omori formula, was 3000 miles, which is about the actual distance.

May 15. Small vibrations, lasting about 40 minutes. No indication of origin shown by the records. The shocks were registered also by the station operated by the Weather Bureau near Washington and according to its reports were probably from a source in Central America or in the adjacent region of the Pacific.

August 13. An indefinite microseism somewhat similar in character to the preceding.

September 21. Perhaps connected with a submarine earthquake reported as causing heavy waves off the coast of Mexico on September 23.

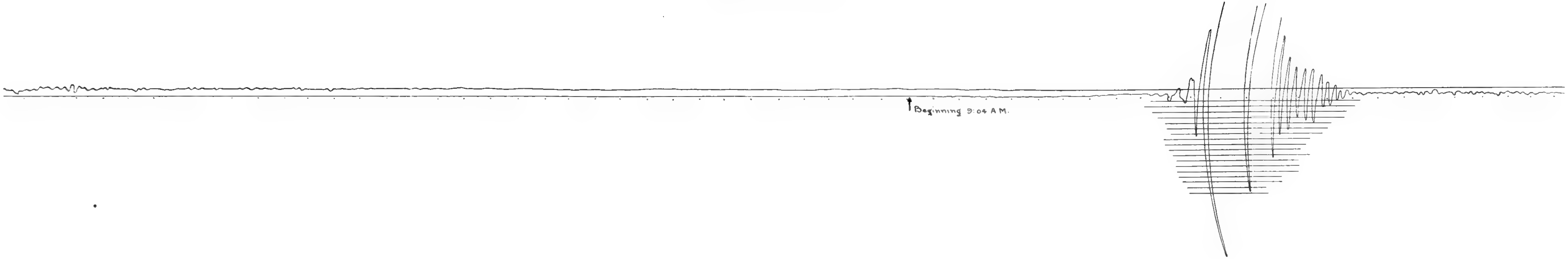
MINERALOGY

In the section of mineralogy, the work of research has progressed along the lines of a monograph on the crystal forms of New York calcite, now nearing completion. A mass of excellent material from a number of widely distributed localities was available for this study, which has already yielded eight forms new to the species.

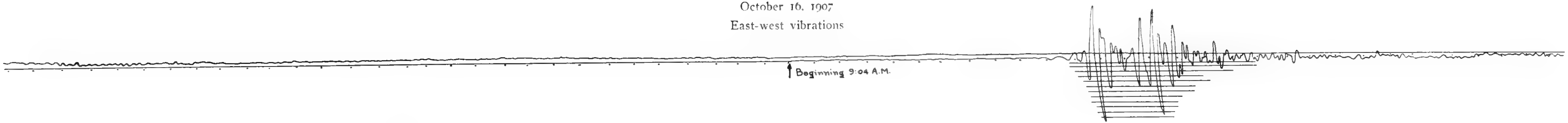
A notable collection of minerals from the celebrated localities of northern New York and Canada has been acquired by purchase from Mr A. F. Nims of Philadelphia, N. Y. This collection which was assembled by the late Charles D. Nims contains many excellent specimens from localities no longer accessible, particularly a series of 225 specimens of danburite from Russell, St Lawrence co., a large suite of oligoclase from Fine, St Lawrence co. including many specimens which give fine moonstone reflections and several large crystals twinned according to the albite law.

Seismograms

October 16, 1907
North-south vibrations

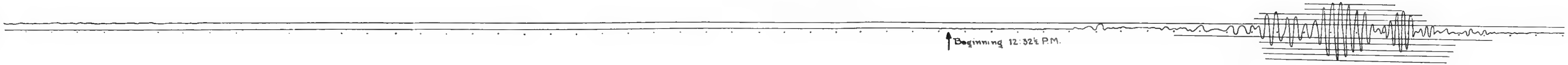


October 16, 1907
East-west vibrations

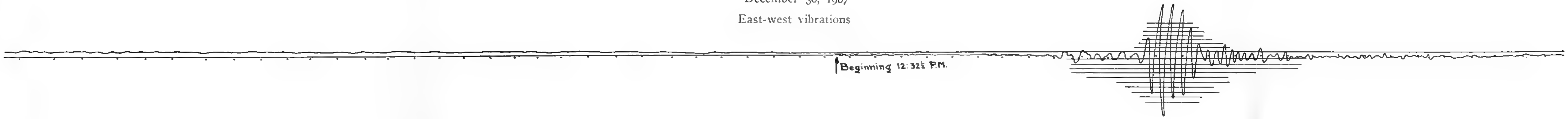


Seismograms

December 30, 1907
North-south vibrations



December 30, 1907
East-west vibrations

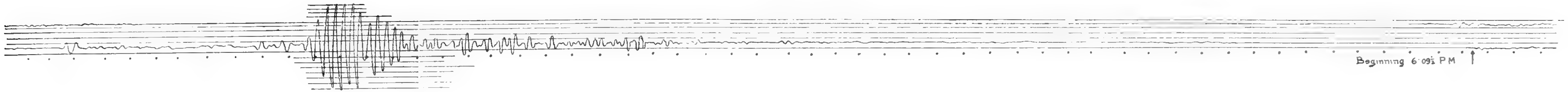


Seismograms

Mexican earthquake

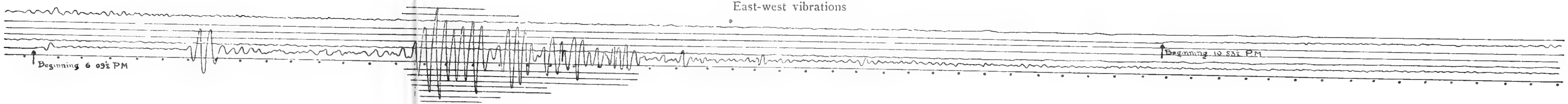
March 26, 1908

North-south vibrations



March 26, 1908

East-west vibrations



PALEONTOLOGY

Early Devonic faunas. The work of the paleontologist on this subject, which has been in process during a number of years, has now been brought to a conclusion so far as concerns its scope as expressed in volumes 1 and 2 of Memoir 9. The second volume of the memoir is now entirely printed. The contents of volume 1 were largely devoted to a close comparison of the Devonic faunas of Gaspé, Quebec with those of New York. In volume 2 these comparisons are extended to the faunas of Dalhousie, N. B., northeastern and northern Maine. The data available for these studies have been somewhat comprehensive and are drawn from regions which have heretofore elicited but slight attention from geologists. The array of facts therefrom presented has thus in considerable measure the value of new knowledge and the conclusions of broader import bearing on the origin and dispersion of the faunas and also indicative of the ancient geography of the continent are here restated.

General conclusions

From the considerations given based chiefly on the analyses of the faunas we may justly draw some reasonable inferences as to the connections of the northeast basins of the early Devonic with those to the south and west. Such inferences can be stated only as probable for there still remains in eastern Quebec and northern Maine an extensive area whose structure is insufficiently known to afford entire security in indicating the boundaries of these passages. Some of these inferences have already been set forth in their proper place but to restate them briefly we conclude:

1 There was a definite and clear passage from Gaspé into New York and the more southern Appalachians during the period of the Helderbergian, where a well defined element of the Helderbergian flourished in the St Alban beds at the base of the Gaspé limestone series.

2 A similar open way existed at approximately or actually the same time, connecting the Dalhousie beds of northern New Brunswick with the Helderbergian of New York.

3 That these two passages seem to have converged and united into one toward the west and south, for while each carries a clear predominance of Helderberg species, the two have comparatively little in common, the fauna of one representing essentially one congeries, that of the other a different congeries of species which are apparently commingled in New York.

4 That in the later stage represented by the profuse fauna of the Grande Grève limestones the northern passage broadened while the Dalhousie passage became extinct; and that passage remained open till much later in the Devonic than Helderbergian time. This fact is evinced by the somewhat lessened though by no means obliterated presence of Helderberg species, by the full development of characteristic Oriskany species in the purest limestone medium and the existence of certain types of still later (Onondaga) age in minor phases of development. The opinion has been expressed that during this period of the Grande Grève limestones the Gaspé Basin was a place of rapid fructification and departure of the fauna toward the southwest.

5 In northern Maine that part of the Devonic represented by the arenaceous sediments of Aroostook county must have pertained to a distinct geographic passageway and have been more or less obstructed southward during the period of the Oriskany. It is quite possible that the same channel was open in its southwest extent during Helderbergian time as indicated by the fauna of the Square Lake limestone, though the differences therein from the New York Helderbergian would still indicate that the way was then not entirely clear open and carried basins of special development.

6 The development of the early Devonic fauna in Piscataquis and Somerset counties, Me., though this series of rocks is apparently not widely separated in continuity or direction from the Aroostook county faunas, is unlike the latter, is more decided in its representation of New York Oriskany types, and yet has many special features in common with those of Aroostook county. At all events this area indicates no entire severance from the former and also declares for a wide open passage southward.

7 As far southward as northern Maine the calcareous character of the Oriskany facies is already lost in spite of its predominance further north and east, yet in this regard it can not be said to conform more fully with the New York development for that, in spite of common repute, has been abundantly shown to be more calcareous than arenaceous, save as the limestones of the New York Oriskany carry large percentages of silica and weather freely to a silicious residuum.

8 The more southerly of these passages show in their fauna traits which the northerly do not, namely, a striking array of affiliations with the Coblentzian fauna of the Transatlantic. It would be difficult to assign any other reason for this than that

the northerly passages ended in the open sea or that that part of the geosyncline in which they flourished failed entirely of continuity with the eastern continent while more southerly parts left freer connection with the east at contemporaneous periods. These affiliations with European faunas have been specifically indicated in the text and imply a well defined westward invasion along these eastern channels in this early period of the Devonic.

9 There was still another quite well defined channel of this time which has not here been specially considered, namely that represented by the beds of Perry, Me.— St John, New Brunswick — Annapolis, Nova Scotia. This southernmost Devonic channel is little known at present. Its fossils have been studied by Dawson and Matthew for the New Brunswick and Nova Scotia occurrences and by Williams for the manifestations in Washington county, Me. We have had extensive collections from the last but the preservation is not favorable and yet good enough to demonstrate that exact information in regard thereto is still to be desired.

10 All these various channels of the early Devonic in the northeast converged southwestward. It is probable however that they passed on southward, after the union of some of them, by different thoroughfares. We here come face to face with certain hypotheses with substantial evidence behind them but they may be stated in terms which will permit of their modification after more detailed knowledge is acquired.

11 The possible trunk troughs entering the southern portions of the geosyncline may be indicated thus:

a **Connecticut valley trough.** The valley of the Connecticut is ancient, probably not differing in origin from the parallel valleys of Lake Champlain and the Hudson as a graben valley or at least outlined by a zone of master faulting. Between the crystalline boundaries of this trough at Lake Memphremagog and southward are evidences showing that it was open earlier that the Devonic, as witness the limestones at Littleton, N. Y. with species of Dalmanites (D. lunatus Lambert) apparently of very late Siluric age.

At Lake Memphremagog are grits carrying Taonurus which have been identified by Dr Ami with the Esopus grit but the argillites both above and below these grits contain fossils; a Dalmanites similar to the D. coxius of the Grande Grève limestone, an Orthoceras of distinctive character, with traces of other fossils. While the Taonurus alone can not be taken as a safe guide for identification with the Esopus horizon of New York yet

the accessory evidence is confirmatory of an age for these deposits essentially equivalent to the Oriskany.

Still farther south at the north line of Massachusetts is the well known occurrence of partly metamorphosed Paleozoic fossils at Bernardston, contained in a limestone and an overlying quartzite. These fossils, of which I have had opportunity to examine large series, are invariably distorted in the quartzite where they most abound so that any resemblance they may assume is too often a resemblance by distortion and a determination thereof carries a large element of fiction and imagination. I believe, however, that the conclusions reached long since by Whitfield in regard to the age of these rocks, that the limestones with large crinoid columns are Helderbergian and the quartzites above with distorted brachiopods are Oriskany, is as close an approximation to the truth as the facts permit.

We must now again call attention to the altitude of the Helderbergian and Oriskanian rocks in the Helderberg mountains of New York. They stand in an escarpment facing the west, north and east overlain by the great thickness of later Devonic constituting the Catskill mountains. Their faces are terraced faces of erosion. Their former extent was in the directions which they face. Beyond any doubt these rocks extended eastward of the Hudson and into western Massachusetts. In the view of Prof. B. K. Emerson, the ultimate authority on the crystallines of Massachusetts, there was here in western Massachusetts an undoubted Precambric north-south ridge whose position above water was indicated by the presence of a Cambric quartzite fringing the greater portion of the outcrops. This may have been and undoubtedly was repeatedly depressed and elevated and the adjoining Siluric masses brought to day but there are no antagonistic considerations for not assuming that it was all transgressed during the Devonic and these Devonic deposits removed entirely by erosion. Toward the north of this region near the north line of the state is a break in the Precambric ridge which is of considerable width, extending into Vermont and this may have well served as a passage for Devonic sediment from New York into the Connecticut trough. East of the Connecticut river there is only a limited area of Precambric near the Rhode Island line, extending south into Connecticut along Long Island sound. This is everywhere margined by a quartzite interpreted as Cambric, and this with the fossil-bearing Cambric localities at Nahant, North Attlebury and Braintree was raised into land and so continued through Siluric

and Devonic time, no rocks of this age being determinable. Professor Emerson regards all the rocks above these mentioned as Carbonic coextensive with the Worcester and Mansfield coals.

These conclusions give evidence enough of an old land barrier bounding a trough of Devonic waters in which the metamorphosed beds of Bernardston at least were deposited. The rest may have been removed by erosion, but in eastern New York between the Hudson and the Massachusetts line and in the direction of the Devonic rocks of Bernardston lies an extensive sheet of coarse clastic material known as the Rensselaer grit which at this point requires brief attention.

Rensselaer grit. Rensselaer and Columbia counties, New York, lying east of the Hudson river and in the general direction of continuity between the Helderberg-Catskill escarpment and the Bernardston Devonic outcrops of the Connecticut valley, are extensively mantled by heavy arenaceous deposits lying unconformably on the unfolded Cambric and Lower Siluric strata beneath. The character and distribution of this rock was clearly outlined by Lieutenant Mather in his report on the first geological district (1843) and it was regarded by him as equivalent in age with the Shawangunk grit of Ulster and Orange counties on the west of the river.

The early geologists held the Shawangunk grit to be an eastern representation of the Oneida grit of central New York and this conception has been quite generally promulgated. Mr T. Nelson Dale has been one of the latest investigators of this region and has acquired an intimate knowledge of the stratigraphic relations of this terrane to the unconformable rocks beneath and we owe to him the conclusion that the upfolding of the lower and upper terranes pertains to different dates, the former to the Taconic and the latter to the Postdevonic or Carbonic movement which also produced the more southerly synclines now represented by Becraft mountain, Columbia county. Mr Dale has correlated the Rensselaer grit with the entire Oneida-Medina sedimentation of eastern New York. In recent investigations carried on by C. A. Hartnagel [*see* Mus. Bul. 107. 1907. p. 51] it is shown with approximate conclusiveness that in the typical sections of central New York the Oneida conglomerate is not a formational unit but actually lies within the Medina sandstones; that, further, the Shawangunk grit, on stratigraphic evidence alone, is of an age much later than the Medina formation and being overlain by rocks of Postsalina age is presumably the eastern representation of Salina

deposition. The confirmation of this conclusion as to the value of the Shawangunk grit was afforded by the discovery of an extensive eurypterid fauna in the interbedded shales of the Shawangunk grit, as described by the writer [*see op. cit.* p. 294]. Mr Hartnagel has indicated the improbability of this Siluric age of the Rensselaer grit or its equivalence to the Oneida-Medina sediments with the following arguments: (1) the extensive gap by nondeposition between the eastern terminus of the Oneida conglomerate, in Herkimer county, and the Rensselaer grit plateau, (2) the long time interval which must be postulated to account for the Taconic folding and the erosion that preceded the deposition of the grit, (3) the gradual transgression northward of arenaceous sediments over the eroded folds, the Shawangunk grits being a more southerly and hence earlier representative of such transgression.

The region of the Rensselaer grit has recently been carefully searched for fossils but though this evidence still fails and its absence can not be explained by secondary changes in the rocks, the stratigraphic considerations indicate the propriety of assigning a distinctly later than Medina age to this formation.

Near the edge of this plateau no beds of later than Trenton age have been observed and there are apparently no outliers to bridge the gap between the late Siluric and early Devonic outliers of Becraft mountain, Mt Bob and the southernmost outliers of Rensselaer grit in the town of Austerlitz, Columbia co. This last named outlier is of especial interest as it lies but 20 miles northeast of Becraft mountain and is a considerable distance south of the main Rensselaer grit plateau. For these reasons it has been closely studied but found to be in no way lithologically different from the grit of Rensselaer county at the north, containing the same alternations of grit with red and greenish slates.

From the presence of only the closing stage of the Upper Siluric at Becraft mountain and in the Helderberg near Albany (Countryman hill),— the two places where the deposits of the Siluro-Devonic basin of New York approach nearest to the Rensselaer grit plateau — it may be properly inferred that the Upper Siluric sea of New York did not extend into the present area of the Rensselaer grit plateau at any time except possibly in the latest (Manlius) stage of that period. In regard to the latter, the problem is the same as in regard to the Helderberg limestones in general which are exposed at Becraft mountain and of which the Rensselaer grit might be conceived as representing the littoral

facies. In favor of this view it may be said that both formations rest on the same basis (Cambric and Lower Siluric slate) and that, on account of the rising of the Taconic mountains in early Siluric time, there may have existed a littoral facies of the Helderberg rocks to the east. But this view is strongly opposed by the fact that the Helderberg rocks do not show any indications of approach to a littoral region at Becraft mountain, but retain the same lithologic characters that they possess over a vast area. There would hence have to be assumed an extremely abrupt and improbable change in facies in the short distance of 20 miles from Becraft mountain to the outlier at Austerlitz. A somewhat different cause is presented by the Oriskany sandstone, Esopus grit and Schoharie grit which not only contain sand and grit at Becraft mountain and in the Helderbergs, but in some places, as at Whiteport and Kingston, contain conglomerate beds. It is altogether probable that the material of these conglomerates was derived from the south and the Oriskany sandstone is too thin a layer (30 feet) at Becraft mountain, to be correlated with the thick mass of the Rensselaer grit (1400 feet). It is, however, possible that the Esopus and Schoharie grits which at Becraft mountain have a combined thickness of 300 feet and are similarly barren in fossils, once continued northeastward into the Rensselaer grit trough. Since they represent an invasion of the sea that came from the south and spread northward in the direction of the Rensselaer grit plateau, and the overlapping Rensselaer grit is clearly the product of an invading, not a receding, sea, it is a reasonable proposition that the Rensselaer grit was deposited in a long narrow embayment extending northward from the Oriskany-Esopus-Schoharie grit sea of southern New York. But in this case also, there is still to be explained the extremely rapid change from the typical Esopus grit of Becraft mountain to the red and green slates and coarse grits of the Austerlitz outlier, and the fact that the Esopus grit is thicker southward (700 feet in Orange county), and thins out toward Becraft mountain. The regular succession of the various members of the Lower and Middle Devonic in Becraft mountain with the same lithologic characters as in the Helderbergs and much farther west and south is in itself cumulative evidence that the Helderberg sea extended farther east than the present Rensselaer plateau and with unchanged or but little changed conditions.

It must further be considered that the Rensselaer grit plateau

represents a deposit in a long submeridional Appalachian trough. Its pebbles of coarse and fine gneiss came from a short distance and the numerous Lower Cambric pebbles probably from places north of the plateau. Its deposits suggest those of an embayment receiving its materials from the north. The entire absence of the fossils occurring in the nearby Becraft mountain formations favors this conception of estuarine conditions.

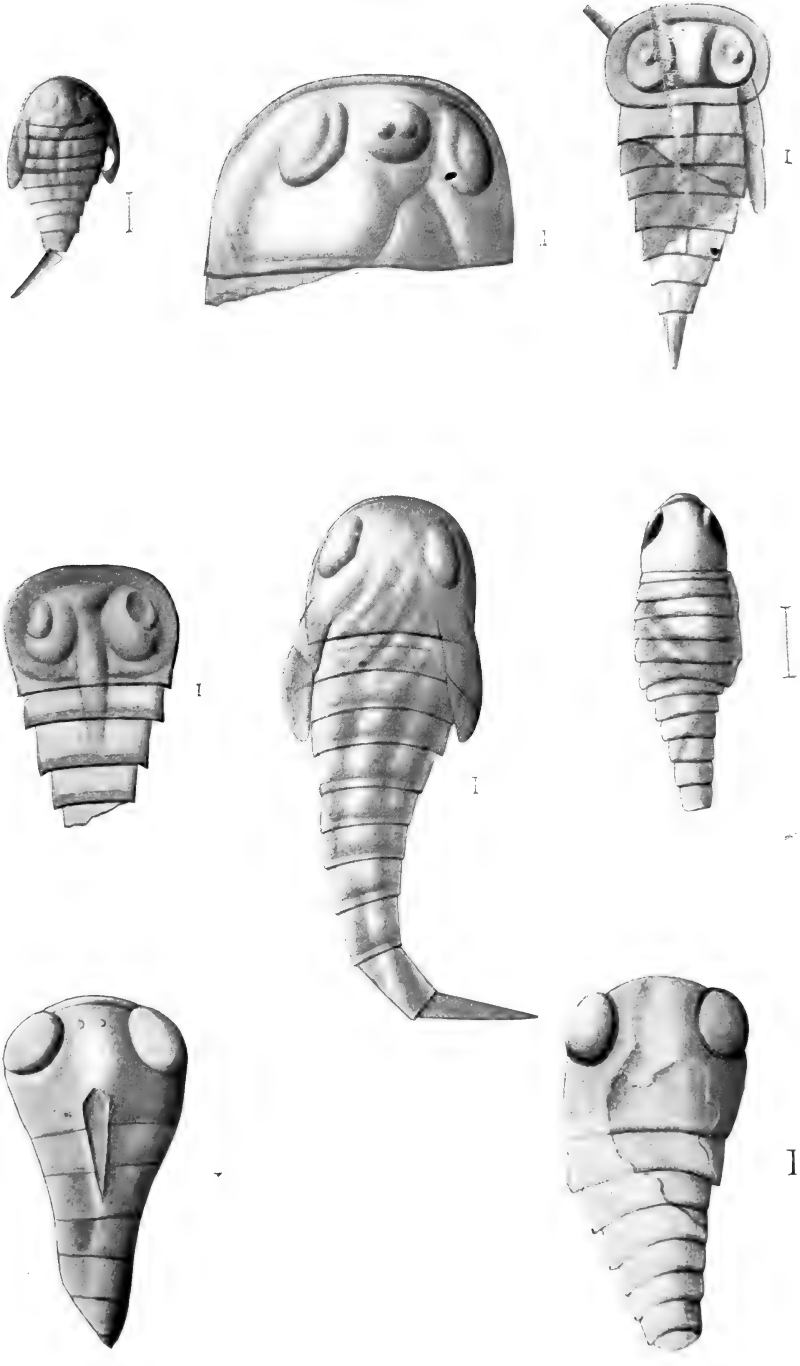
The evidence compels us to grant that the Rensselaer grit is of later than Siluric age; there is some good reason for regarding it an eastern deposit contemporary with the early Devonic, but the alternative proposition stands open, that its estuarine character and great thickness suggest identity with the Catskill beds which stand sheer on the other side of the Hudson river in hights of several thousand feet and only 30 miles away from the outlier at Austerlitz.

b **Dana** indicated by the term "**Worcester trough**," a hypothetical Appalachian waterway in which the Carbonic beds of Worcester, Mass., eastern Massachusetts and Rhode Island were deposited. This is a more easterly northeast-southwest passage than the Connecticut trough and we can derive no satisfactory evidence of its existence during the Devonic. Indeed the statements made above indicate that, though this region may have been receiving deposits during the Cambric, it was a land body during the period with which we are now concerned and was not opened again for the reception of sediments till the beginning of the Carbonic. We are compelled therefore to dismiss the Worcester trough as having any bearing, from present evidence, on the theme before us.

c **The Perry-St John-Annapolis Devonic channel,** lying further to the south and east of those we have considered, is today represented by deposits still largely covered by the sea. Its far easterly course and its isolation seem to indicate that it had nothing in common with the rest, that it must have entered the southern Appalachians by a way of which we know nothing.

12 We are thus impelled to conclude from the factors given that the line of passage southwestward from all the channel basins we have specially discussed, into the New York Helderbergian-Oriskany channel was by way of the Connecticut trough; that the Gaspé, Dalhousie, Aroostook and in a sense the Piscataquis-Somerset channels were independent isolated passages for a part of their distance only and that they converged eventually southward to contemporaneous or successive unity.

Plate I



Eurypterida

13 We have observed that the passage from New York through to Gaspé and New Brunswick was undisturbed during the earliest stages of the Devonic. Probably in the later stage represented by the extensive Grande Grève limestones it was less clear, the channel widened out into a basin of rapid propagation from which migration to the southwest took place freely. We believe the evidence fully indicates that during all these stages of the Eodevonic the direction of migration was from the north inward and southward. Reference has been made to the occurrence of the Eodevonic on St Helens island, Montreal and to the presumption that it indicates the remnant of a backset along the St Lawrence trough of these waters, rather than any connection with New York through the Champlain trough. We find no reason for modifying this view as there is no single factor which presumes a Paleozoic water connection along the Champlain graben during a period so late as the Devonic.

14 The Gaspé sandstones indicate (as we have suggested) a general breaking down of the barriers of the northern channel, by a transgression over the Siluric beds adjoining and a widening out of the area in such a way as to constitute in large part flood deposit or barachois conditions throughout the eastern part of the Gaspé peninsula. These conditions continued throughout the Middle Devonic as shown by the notable percentage of New York Hamilton species in these rocks commingled with highly typical survivors of the earlier or Grande Grève fauna. The New York species are here clearly the invaders, having entered this province by the still open waterway from the southwest. The remains themselves, whether of Grande Grève or Hamilton species, we regard as overwashed into their present position from outside the barrier bounding the barachois and not native to the sandy terrigenous sediments, abounding in plant remains with which they are associated.

Monograph of the Eurypterida. Recent years of field exploration have brought to light very extensive collections of these interesting ancient crustacea from New York and beyond any doubt such a wealth of material representing this extinct order has never before been brought together. It has been the purpose of the Paleontologist to utilize this exceptional material as the basis of a revision of the group and as an opportunity for expanding and summarizing his previous publications on this subject. During the past year the Assistant Paleontologist has been able to devote considerable study to this subject with results of much

interest. The investigation has progressed sufficiently to permit the restoration of all the hard anatomy of the principal genera of the order. Stylonurus, which has been known as one of the largest of these creatures, attaining a length of 5 — 6 feet, proves, on study of smaller species from Otisville, materially different in structure from the generally accepted restoration. It has also been possible to restore the genera Eusarcus and Dolichopterus with all their appendages and to assemble all parts of the integument of the largest Pterygotus occurring in the New York formations. Other results of significance are the recognition of the genus Drepanopterus; the identity of the eye structure of Pterygotus with that of Limulus shown by the presence of an outer smooth thick cornea which is separable from an inner layer of lenses; the demonstration that the chelicerae of Pterygotus consist of long unjointed arms carrying the terminal pincers; and the close relationship of the genera Stylonurus and Dolichopterus brought out by transitional forms and the identity of new structures observed in their New York representatives.

The genus Stylonurus is resolved into three subdivisions for which the subgeneric terms Stylonurus *sensu stricto,* Ctenopterus and Homalopterus are introduced. These divisions are based mainly on the character of the legs.

The genus Hughmilleria has been shown to agree in the structure of its compound eyes with Eurypterus, although the position of these suggests a closer relationship to Pterygotus.

The Cambric genus Strabops possesses the full complement of 12 dorsal segments instead of 11, as hitherto supposed, and has small compound eyes placed far back and near the lateral margin. The investigation of the larval forms of a number of Siluric species has shown that some of these pass through a stage identical in its most important features with the adult Cambric Strabops.

The ontogeny of Eurypterids is for the first time investigated and the development of species of the genera Eurypterus, Eusarcus, Hughmilleria, Pterygotus and Stylonurus is traced as far back as the nepionic or larval stage, and a number of larval characters are established which appear to be common to all and of significance in phylogenetic relation.

Both the restorations of the genera and the investigation of the ontogeny have allowed conclusions on the phylogeny of the Eurypterids, as well as their morphology and mode of life.

Eusarcus newlini

The following North American genera and species are noted. Those from the area of the State of New York or its borders are marked by an asterisk:

Eurypterus
- *approximatus *Hall & Clarke*
- boylei *Whiteaves*
- kokomoensis *Miller & Gurley*
- *lacustris *Hall*
- *mansfieldi *Hall*
- *maria *Clarke*
- mazonensis *Meek & Worthen*
- *microphthalmus *Hall*
- *pachychirus *Hall*
- *pennsylvanicus *Hall*
- *pittsfordensis *Sarle*
- *potens *Hall*
- *prominens *Hall*
- *pustulosus *Hall*
- *remipes *DeKay*
- *robustus *Harlan*
- *stylus *Hall*
- *sp. nov.*

Eusarcus
- *cicerops (*Clarke*)
- newlini (*Claypole*)
- *scorpionis *Grote & Pitt*

Dolichopterus
- *macrochirus *Hall*
- *otisius (*Clarke*)
- **sp. nov.*

Drepanopterus
- *sp. nov.*

Echinognathus
- clevelandi *Walcott*

Hughmilleria
- *shawangunk *Clarke*
- *socialis *Sarle*
  - *var.* robustus *Sarle*

Pterygotus
- *cobbi *Hall*
- *grandis (*Pohlman*)
- *globicaudatus *Pohlman*
- *macrophthalmus *Hall*
- **sp. nov.*

Strabops
- thacheri *Beecher*

Stylonurus (Ctenopterus)
- *beecheri (*Hall*)
- *cestrotus (*Clarke*)
- *excelsior *Hall*
- **myops* (Clarke)
- **sp. nov.*
- **sp.*
- **sp.*
- **sp.*
- **sp.*

This list shows that with the exception of six species all American forms known thus far have come either from New York or closely adjoining districts.

The following species names have been rejected as synonyms:

E. eriensis *Whitfield*
E. giganteus *Pohlman*
Eusarcus grandis *Grote & Pitt*
Pterygotus acuticaudatus *Pohlman*
P. buffaloensis *Pohlman*
P. bilobus *Pohlman*
P. cummingsi *Grote & Pitt*
P. osborni *Hall*
P. quadraticaudatus *Pohlman*

The James Hall Memorial Tablet

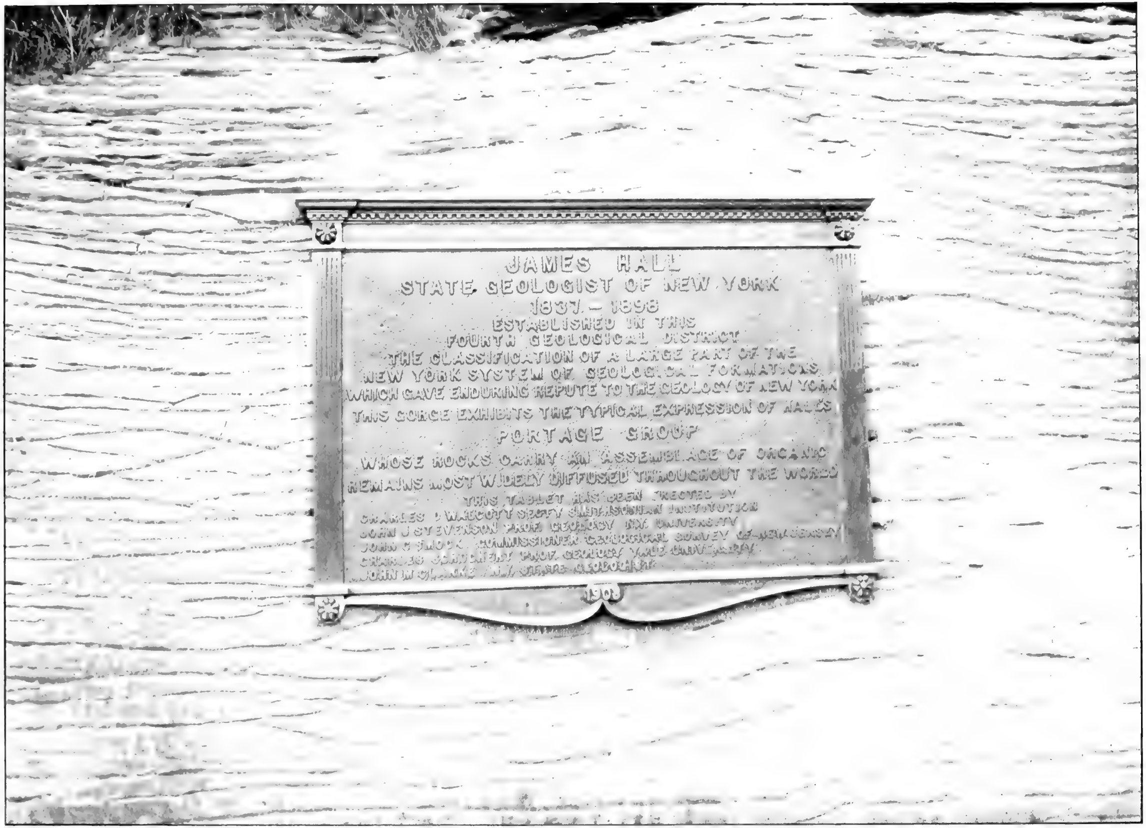
It has seemed appropriate to some of the late Prof. James Hall's active associates on the Geological Survey of this State to commemorate the beginning of his important work by the erection of an appropriate if modest memorial. Professor Hall, on the organization of the Geological Survey in 1836, was designated as assistant to Dr Ebenezer Emmons in the latter's survey of the second or northern district of the State. The following year however he was appointed geologist in charge of the fourth or western district. Here he laid the foundation not alone of his later achievements but of the classification of a large part of the New York series of geological formations. His final report on the fourth district issued in 1843 has from that date been a compendium and standard exposition of the geology of western New York and on this foundation was reared the superstructure of his still greater accomplishments in the paleontology of New York. It was from the rocky gorge of the Genesee river that the geologist was best able to decipher the succession of the rock strata and on one of these rock cliffs close to the Genesee river amid the very picturesque surroundings of Glen Iris, a bronze tablet commemorative of these facts has been erected with the approval of the State's trustees of Letchworth Park, The American Scenic and Historic Preservation Society.

III

REPORT OF THE STATE BOTANIST

The work of the State Botanist the past year has been chiefly a continuation of the work of the preceding year. It has consisted of the collection and preparation of specimens of plants for the herbarium, the preparation of descriptions of such as do not appear to have been described, and in some cases the preparation of colored illustrations of them, the testing of the edible qualities of promising species and the identification of specimens of plants brought or sent to the office by correspondents and others who have desired information concerning them. A constant outlook has been kept for indications of the chestnut disease that has recently attacked chestnut trees with destructive consequence in the parks of New York city and Brooklyn and their vicinity. A special trip of investigation was made to Dutchess county, which had been reported as the most northern limit known of its occurrence. No indication of the disease was found there, nor in the counties of Albany,

Plate 3



James Hall tablet, Letchworth Park; on a weathered joint face of Portage sandstone

Plate 4

James Hall tablet, Letchworth Park, facing the Genesee river

Rensselaer and Steuben where special search has been made for it. On the other hand, wherever special observation has been made of chestnut trees they have appeared to be in good health and vigor and unusually full of fruit. While the abundant crop of fruit may prove to be somewhat exhaustive of the vigor of the trees it does not seem probable that the serious consequences of the disease that have been predicted by some writers will be realized. Very destructive outbreaks of parasitic fungi are usually dependent on unusual climatic conditions and are of short duration. In no case are they likely to exterminate the host plant.

Specimens of plants sent or brought to the office of the State Botanist for identification or for other information are always welcome, for in this way not only is the desired information obtained by the person seeking it but also interesting and valuable plant specimens are sometimes added to the museum collections. The number of identifications made in such cases the past year is 1640. The number of persons for whom identifications have been made is 127.

In many parts of the State the season just passed has been strangely adverse to the mushroom crop. Rain was not lacking in the early part of the season, but the prevailing low temperature apparently prevented the development of mushrooms that otherwise would doubtless have appeared. Later in the season when the prevailing temperature was more favorable, the necessary rain and moisture were lacking. This unfavorable condition continued so late in the season that those species which usually appear in August and September either failed entirely to appear or appeared much later in the season. Reports state that very large crops of the common mushroom, Agaricus campester L. have appeared in a few localities in November. This is nearly or quite two months later than its usual time. The light fall rains, which were unusually late, gave the mycelium its first opportunity to develop. These rains were followed by exceptionally fine mild and sunny weather which was very favorable to the development and spread of the mycelium or "spawn." The result was a very abundant crop of mushrooms in those places where a rich soil aided the favorable weather conditions.

The new species and varieties of fungi described by the State Botanist are now so numerous and the periodicals, reports and bulletins containing these descriptions are so many and so scattered and the inquiries concerning the place where one and another

of them can be found are so frequent that it has seemed quite desirable that a list of these species be given with the places of their publication. This has been prepared and will doubtless be of aid to all interested in mycology.

IV

REPORT OF THE STATE ENTOMOLOGIST

The State Entomologist reports that a number of species of insects have inflicted serious injuries upon both fruit and shade trees. A most interesting phenomenon was the widespread and abundant flight of the snow-white linden moth. An unusual feature was the capture, within the limits of the city of Albany, of two specimens of a small, green, subtropical cockroach.

Fruit tree insects. Fruit trees in the western part of the State were seriously injured in some sections by the cigar case bearer, a species which is very rarely abundant enough to cause material damage in the Hudson river valley. Depredations by this case bearer were frequently associated with severe damage to a small plant mite known as the blister mite. Western fruit growers were also greatly exercised by the caterpillars of the white marked tussock moth eating into the young fruit, a troublesome departure from the normal habit. The fall cankerworm was unusually abundant and destructive on eastern Long Island and in the vicinity of New York city. The San José scale is one of the most serious insect pests of the horticulturist. The warm, dry weather during the latter part of the season was favorable to the unrestricted multiplication of this insect, and in some cases orchards have become very badly affected. Our observations show that, as a rule, fruit growers are experiencing much less trouble in keeping this scale insect in check than was the case in earlier years. Early spring applications of a lime-sulfur wash are giving good results. Some parties are finding satisfaction from applications of a miscible or so called " soluble " oil. We have preferred, as a rule, to confine our recommendations to a material like the lime-sulfur wash, which is not only effective but safe and also valuable in controlling fungus diseases. Numerous observations have been made on the above mentioned and other insects.

It is gratifying to state that conditions in the Chautauqua grape belt have materially improved, so far as injury by the grape root worm is concerned. Though this insect is generally distributed

throughout the grape belt, severe injuries by it have been confined to restricted areas. The grape blossom midge was responsible for an unprecedented outbreak, and destroyed from 50 to 75% of the blossoms on one acre of Moore's early grapes at Fredonia. It was generally present throughout the grape section and somewhat abundant in limited portions of certain vineyards. It is probable that this species has been responsible for failure to fruit in other cases where the losses were attributed to some unknown cause or possibly to unfavorable weather conditions. This insect is now under investigation. We hope to solve its life history next spring, a necessary preliminary to devising a practical method of preventing serious injury in the future.

Shade tree protection. Ravages by the elm leaf beetle have been very severe in many Hudson valley cities and villages and, as a result, popular interest in the welfare of our shade trees has greatly increased. This concern has been accentuated by extensive defoliations inflicted by the white marked tussock moth, a species which has been quite injurious in Buffalo for some years past.

Injuries by these and other shade tree pests have emphasized most strongly the recommendations of the Entomologist and, as a result, more than ever before is being done to protect shade trees. The work of the city forester of Albany has been very beneficial in spite of certain hindrances. The city of Buffalo has at last committed itself to a definite policy of shade tree protection. A forester has been appointed and excellent work already accomplished in that municipality. The authorities of several villages have given careful consideration to shade tree protection and there is a good prospect that more will be done another year. The work against the gipsy moth, noticed below, has resulted in a marked improvement in the spraying outfit. We believe that certain of this apparatus, modified to suit our conditions, could be adopted to advantage and would prove of much benefit, since, by making the spraying easier and quicker, it would afford largely increased efficiency. Work upon shade tree insects, consisting mostly of local examination and recommendation, has consumed much time and has been productive of marked improvement in the welfare of the trees.

Gipsy and brown tail moths. These two insects have continued their injurious work in Massachusetts, the first named being by far the more destructive. The gipsy moth has been found in small numbers at both Springfield and Greenfield, Mass., as recorded in

our previous report. Points where this insect was likely to become established have been closely watched and as yet it has not been found in this State. A warning placard, illustrating this species and the brown tail moth, has been conspicuously posted in many post offices and other public places in the State. Prompt and efficient treatment of isolated colonies, should they be found in this State, is of utmost importance if extended injury is to be avoided.

The work against the gipsy moth in Massachusetts, as revealed by a personal examination the past summer, is being prosecuted with great vigor. The residential sections are in excellent condition, though large woodland areas have been seriously damaged. The work with parasites, conducted by that state in cooperation with the federal government, is most encouraging. The staff in charge of this work has been materially strengthened during the past year, and its efficiency increased by the dispatch of a special agent to Japan, who secured some promising parasites which already have been bred through one generation in this country, and lead to the hope that they may soon become important factors in controlling this species. The control of the gipsy and brown tail moths should be encouraged in every possible manner, since it is much more economical to check them in a restricted area than to allow the struggle to extend over a wide territory.

Forest insects. The extensive outbreaks by the green striped maple worm, recorded in our previous report, have been continued in southern Rensselaer county, and it is probable that this species was associated, as last year, with the antlered maple caterpillar. The depredations by the snow-white linden moth, also noticed in our preceding report, were continued in the Catskills and extensive injuries in the Adirondacks were also brought to our attention. The only hope of preventing damage of this character is by the encouragement of natural agents, prominent among which may be mentioned native birds. The efficiency of insectivorous birds has been repeatedly emphasized by the Entomologist.

The bark borers or Scolytidae comprise a large number of very destructive species. The literature relating to this group is greatly scattered and comparatively inaccessible, hence a bibliographic catalogue is a necessary preliminary to further work upon these insects. We have submitted, as an appendix to the Entomologist's report, a catalogue of the described Scolytidae of America north of Mexico by Mr J. M. Swaine.

Gall midges. The studies upon this important group have progressed very successfully. We have already prepared preliminary keys for the separation of most forms into subfamilies, tribes, genera and species, together with tables giving the food habits of those which have been reared. Some idea of the magnitude of this work may be gained when it is remembered that we have studied over 300 bred species and now recognize 700 species, representing about 50 genera. The systematic arrangement alone of this large number of microscopic insects is an immense task; in addition to the above, many descriptions have been drafted and numerous biological notes transcribed.

The later work upon these insects has of necessity been confined mostly to systematic study, owing to the fact that material was coming in faster than it could be worked up in a satisfactory manner. We have succeeded in rearing during the past season, in spite of the pressure of other matters, about 75 species, the biology of most of which was previously unknown. There is on hand a large series of galls from which some extremely desirable material may be expected another season. The work upon this group is so well in hand that there should be no difficulty in bringing it to a successful conclusion in the near future.

The rearing and care of breeding jars containing gall midges requires much time. Assistant Entomologist D. B. Young had general charge of this work and was ably assisted by Miss Fanny T. Hartman. In addition, Mr Young rendered material service in separating the large material into the major groups, while Miss Hartman has made over 600 microscopic preparations.

Flies and mosquitos. The ubiquitous and well known house fly has been the recipient of much attention because recent investigations show it may be the responsible agent, under certain conditions, in the dissemination of typhoid fever and other grave intestinal disorders. Observations upon its life history and habits have established the practicability of largely reducing if not eliminating this menace to health and personal comfort. A press bulletin on this insect was issued and this will be supplemented by a more extended account.

There is much interest in the control of mosquitos. The Entomologist inspected the work in progress on the Flushing meadows and has kept in touch with similar operations in other localities. Attention has also been given to the control of fresh-water species, especially the malarial carrying form. The practicability of such

work has been established and we look for a great extension of interest in the local suppression of these annoying pests.

Aquatic insects. The studies of insects inhabiting our fresh waters have been continued by Dr James G. Needham. His report on the work done at Old Forge was made public in the Entomologist's report for 1907. Dr Needham is now engaged in completing his monographic account of the stone flies (Plecoptera), a work which should be ready for the printer some time during the coming winter. Dr Betten has made good progress in his studies of the caddis flies (Trichoptera), and it is expected that his work upon this group will soon be completed.

Publications. Many popular economic notices have been contributed by the Entomologist to the agricultural and local press, and a few accounts of more general interest have been widely disseminated through the agency of the associated press. A large number of Cecidomyiidae, reared in 1907, rendered it advisable to publish preliminary descriptions of these, and a reprint from the report for that year, entitled *New Species of Cecidomyiidae II,* was issued October 26, 1907. Owing to numerous delays in printing, the report for last year did not appear during the fiscal year, as a large amount of time was necessarily expended upon the more technical part in carrying it through the press.

Collections. The additions to the collections have not been as numerous as in preceding years, owing to the necessity of giving more attention to the arrangement and classification of material on hand. A number of previously unknown Cecidomyiidae were reared and several important gaps in our knowledge respecting this group filled.

Several extremely desirable accessions, aside from those mentioned above, have been made to our biological collections. One of the most interesting was a complete series representing the egg, larva, pupa and adult of the remarkable Taeniorhynchus perturbans Walk., generously contributed by Mr J. Turner Brakely of Hornerstown, N. J., the discoverer of the early stages and one of the most active in working out the life history of this previously very elusive species.

Two important additions have been made to the exhibit collections, namely, an enlarged model of the onion fly, showing the egg, maggot, puparium, adult fly and an onion infested by maggots; also an enlarged model of the cigar case bearer, showing its work upon apple leaves. Both of these were executed by Mrs Otto Heidemann of Washington, D. C.

The arrangement and classification of the collection has received much attention. Assistant Entomologist D. B. Young has separated the Staphylinidae into their major groups and determined many species. He has also given considerable time to the arrangement of the Syrphidae. The completion of the catalogue of the Hill collection occupied much time during the past year. Miss Hartman also assisted in the preparation of this catalogue and has done much general curatorial work, such as mounting, labeling and caring for insect specimens.

General. The tacit limitations of earlier years confined the studies of the economic entomologist to insect enemies of well recognized farm crops, such as corn, potatoes, fruits, or to those forms annoying or injurious to domestic animals. The later extensive insect depredations upon shade and forest trees have served to emphasize the practical importance of this field. The more recent discoveries that malaria and yellow fever are transmitted by mosquitos, and that typhoid fever and other intestinal diseases may be conveyed by house flies, has made the entomologist a most welcome ally of the sanatorian. Furthermore, careful investigations of injurious and dangerous insects have repeatedly demonstrated the value of such studies as a necessary preliminary to practical control work on the farm or marsh, in the orchard or even about the home. Prophylactic measures against yellow fever, malaria and typhoid must depend in large measure upon an intimate knowledge of the habits of certain insects and their part in the dissemination of the dangerous germs. The study of injurious insects is by no means completed. There is great need of investigations that can not be adequately conducted with our present resources. The exhibit collections should be strengthened by a series of well executed enlarged models of the smaller, more injurious insects. Such a departure would increase the practical and educational value of the entomologic exhibits, particularly as the significance of some of the more recent discoveries can not be adequately portrayed without such aid.

V

REPORT ON THE ZOOLOGY SECTION

The present Zoologist did not enter upon his duties until the 1st of February last, and considerable time was necessarily devoted to becoming acquainted with the material at present in the museum and with its most urgent needs.

Inasmuch as the work upon the new museum building has already started, it seemed best to devote as much time as possible to the collections in order that a proper showing may be made when the new quarters are ready. With this end in view the specimens on hand have been carefully examined and a list made of the material of which there is special need. It is intended to illustrate by groups as far as possible all the mammals of the State and as the total number of these is only 81, including 10 of the Cetacea (whales) which would not be suitable for such treatment, there appears no reason why at least the majority should not be so shown. At present 18 species, not including the whales, are not represented in the collections and many others only by old and worn specimens. Donations along these lines would be most welcome.

The collection of birds is in much better condition and the number of New York species entirely lacking has been reduced to 18, six of which belong to the hypothetical list.

We have been particularly fortunate this year in receiving from Dr R. W. Shufeldt, as a gift, his very fine collection of disarticulate avian skeletons. This collection is probably equal to any in this country. Two hundred species mostly North American are represented in it, the majority by complete skeletons. The collection, of which the complete list is given under accessions, consists of 237 complete skeletons, 48 skulls, 63 sterna and 17 hyoids. It should also be mentioned in this connection that the collection includes many of the types described and figured in Dr Shufeldt's papers, among which are found complete male and female skeletons of the Carolina paroquet (Conuropsis carolinensis) now nearly extinct.

To the collection of reptiles and amphibians a number of the Ward casts have been added, and the old faded alcoholic specimens are being replaced by new ones as opportunity arises.

The best method of exhibiting the fish is a problem still undecided. The taxidermist has, however, a method of mounting these which it is believed will prove a step in advance of anything yet accomplished. He is at present working on a group showing yellow perch (Perca flavescens), and sunfish (Eupomotis gibbosus) in their natural surroundings.

The muskrat group upon which work was begun last year has been placed on exhibition. This shows two muskrats near a muskrat house, while the rear of the group is a cross section of the chamber and passageways.

The group of black bear has been received, but will not be displayed until such accessories have been added as seem desirable to make the scene as attractive as possible.

Three more bird groups have been put on exhibition. One shows a sora rail with nest and young; the other two are winter scenes. the first made up of three snow buntings and the other of Canadian nuthatches and American goldfinches in their winter plumage.

The taxidermist is at present constructing, in addition to the above mentioned fish group, a group of mink and one of white-footed mice. These should all be ready for exhibition by the spring.

Birds of New York. In 1844 this State published as one of the volumes of the *Natural History of New York* a comprehensive and finely illustrated treatise on the birds of the State, prepared by the eminent ornithologist, James E. De Kay. Since its date of issue this work has been of fundamental value to all students of the birds and may justly be regarded as, in a large degree, the primary inspiration of the present widespread interest among the people of the State in the science of ornithology.

In 1904, 60 years from its publication, I urgently recommended to the Commissioner of Education that a restudy of this field was desirable in order to bring together increments to knowledge during the long period which had elapsed without interest therein on the part of the State and to meet the very general and lively concern in the subject among our citizens.

Consequent on the approval of this recommendation the preparation of a monographic treatment of the subject was assigned to Prof. E. Howard Eaton. The undertaking was a large one, involving great labor, accurate knowledge and painstaking devotion. But it has now been carried so far that the conclusion of the work is in sight and the first of the two quarto volumes is about to be delivered from the press. This volume 1 will carry something over 300 pages and 42 plates in color with various distribution tables and numerous cuts.

A synopsis of the first volume is here appended:

BIRDS OF NEW YORK. VOLUME I

Class **Aves**
Subclass **Carinatae**

Order Pygopodes
Diving birds

Family Colymbidae
Grebes

Colymbus holboelli (*Reinhardt*)
(*Holboell grebe*)
Colymbus auritus *Linnaeus*
(*Horned grebe*)
Podilymbus podiceps (*Linnaeus*)
(*Pied-billed grebe*)

Family Gaviidae
Loons

Gavia immer (*Brünnich*)
(*Loon*)
Gavia arctica (*Linnaeus*)
(*Black-throated loon*)
Gavia stellata (*Pontoppidan*)
(*Red-throated loon*)

Family Alcidae
Auks, Guillemots etc.

Fratercula arctica (*Linnaeus*)
(*Puffin*)
Cepphus grylle (*Linnaeus*)
(*Black guillemot*)
Cepphus mandti (*Lichenstein*)
(*Mandt guillemot*)
Uria troile (*Linnaeus*)
(*Murre*)
Uria lomvia (*Linnaeus*)
(*Brünnich murre*)
Alca torda *Linnaeus*
(*Razor-billed auk*)
Alle alle (*Linnaeus*)
(*Dovekie*)

Order Longipennes

Family Stercorariidae
Skuas and jaegers

Megalestris skua (*Brünnich*)
(*Skua*)

Stercorarius pomarinus (*Temminck*)
(*Pomarine jaeger*)
Stercorarius parasiticus (*Linnaeus*)
(*Parasitic jaeger*)
Stercorarius longicaudus *Vieillot*
(*Long-tailed jaeger*)

Family Laridae
Gulls and terns

Pagophila alba (*Gunnerus*)
(*Ivory gull*)
Rissa tridactyla (*Linnaeus*)
(*Kittiwake*)
Larus hyperboreus *Gunnerus*
(*Glaucous gull*)
Larus leucopterus *Faber*
(*Iceland gull*)
Larus kümlieni *Brewster*
(*Kümlien gull*)
Larus marinus *Linnaeus*
(*Great black-backed gull*)
Larus argentatus *Pontoppidan*
(*Herring gull*)
Larus delawarensis *Ord*
(*Ring-billed gull*)
Larus atricilla *Linnaeus*
(*Laughing gull*)
Larus philadelphia (*Ord*)
(*Bonaparte gull*)
Larus minutus *Pallas*
(*Little gull*)
Xema sabini (*Sabine*)
(*Sabine gull*)
Gelochelidon nilotica (*Hasselquist*)
(*Gull-billed tern*)
Sterna caspia *Pallas*
(*Caspian tern*)
Sterna maxima *Boddaert*
(*Royal tern*)
Sterna sandvicensis acuflavida (*Cabot*)
(*Cabot tern*)
Sterna trudeaui *Audubon*
(*Trudeau tern*)

Sterna forsteri *Nuttall*
(*Forster tern*)
Sterna hirundo *Linnaeus*
(*Common tern*)
Sterna paradisaea *Brünnich*
(*Arctic tern*)
Sterna dougalli *Montagu*
(*Roseate tern*)
Sterna antillarum (*Lesson*)
(*Least tern*)
Sterna fuscata *Linnaeus*
(*Sooty tern*)
Hydrochelidon nigra surinamensis (*Gmelin*)
(*Black tern*)

Family **Rhynchopidae**
Skimmers
Rynchops nigra *Linnaeus*
(*Black skimmer*)

Order **Turbinares**
Tube-nosed swimmers

Family **Puffinidae**
Fulmars, Shearwaters and Petrels
Fulmarus glacialis (*Linnaeus*)
(*Fulmar*)
Puffinus borealis *Cory*
(*Cory shearwater*)
Puffinus gravis (*O'Reilly*)
(*Greater shearwater*)
Puffinus puffinus (*Brünnich*)
(*Manx shearwater*)
Puffinus lherminieri *Lesson*
(*Audubon shearwater*)
Puffinus griseus (*Gmelin*)
(*Sooty shearwater*)
Aestrelata hasitata (*Kuhl*)
(*Black-capped petrel*)
Aestrelata scalaris *Brewster*
(*Scaled petrel*)

Family **Procellariidae**
Stormy petrels
Thalassidroma pelagica (*Linnaeus*)
(*Stormy petrel*)
Oceanodroma leucorrhoa (*Vieillot*)
(*Leach petrel*)
Oceanites oceanicus (*Kuhl*)
(*Wilson petrel*)

Order **Steganopodes**
Totipalmate birds

Family **Phaethontidae**
Tropic birds
Phaethon americanus *Grant*
(*Yellow-billed tropic bird*)

Family **Sulidae**
Gannets
Sula leucogaster (*Boddaert*)
(*Booby*)
Sula bassana (*Linnaeus*)
(*Gannet*)

Family **Phalacrocoracidae**
Cormorants
Phalacrocorax carbo (*Linnaeus*)
(*Cormorant*)
Phalacrocorax auritus (*Lesson*)
(*Double-crested cormorant*)

Family **Pelecanidae**
Pelicans
Pelecanus erythrorhynchus *Gmelin*
(*American white pelican*)
Pelecanus *fuscus Linnaeus*
(*Brown pelican*)

Family **Fregatidae**
Man-o'-war birds
Fregata aquila (*Linnaeus*)
(*Man-o'-war bird*)

Order **Anseres**
Lamellirostral swimmers

Family **Anatidae**
Ducks, Geese and Swans

Subfamily **Merginae**
Mergansers
Mergus americanus *Cassin*
(*American merganser*)
Mergus serrator *Linnaeus*
(*Red-breasted merganser*)
Lophodytes cucullatus (*Linnaeus*)
(*Hooded merganser*)

Subfamily **Anatinae**
River ducks

Anas platyrhynchos *Linnaeus*
(*Mallard*)
Anas rubripes *Brewster*
(*Black duck*)
Chaulelasmus streperus (*Linnaeus*)
(*Gadwall*)
Mareca penelope (*Linnaeus*)
(*Widgeon*)
Mareca americana (*Gmelin*)
(*Baldpate*)
Nettion crecca (*Linnaeus*)
(*European teal*)
Nettion carolinensis (*Gmelin*)
(*Green-winged teal*)
Querquedula discors (*Linnaeus*)
(*Blue-winged teal*)
Querquedula cyanoptera (*Vieillot*)
(*Cinnamon teal*)
Spatula clypeata (*Linnaeus*)
(*Shoveler*)
Dafila acuta (*Linnaeus*)
(*Pintail*)
Aix sponsa (*Linnaeus*)
(*Wood duck*)

Subfamily **Fuligulinae**
Sea and bay ducks

Netta rufina (*Pallas*)
(*Rufous-crested duck*)
Marila americana (*Eyton*)
(*Redhead*)
Marila vallisneria (*Wilson*)
(*Canvasback*)
Marila marila (*Linnaeus*)
(*American scaup duck*)
Marila affinis (*Eyton*)
(*Lesser scaup duck*)
Marila collaris (*Donovan*)
(*Ring-necked duck*)
Clangula clangula americana (*Bonaparte*)
(*American golden-eye*)
Clangula islandica (*Gmelin*)
(*Barrow golden-eye*)
Charitonetta albeola (*Linnaeus*)
(*Buffle-head*)
Harelda hyemalis (*Linnaeus*)
(*Old squaw*)
Histrionicus histrionicus (*Linnaeus*)
(*Harlequin duck*)
Camptorhynchus labradorius (*Gmelin*)
(*Labrador duck*)
Somateria dresseri (*Sharpe*)
(*American eider*)
Somateria spectabilis (*Linnaeus*)
(*King eider*)
Oidemia americana *Swainson*
(*American scoter*)
Oidemia deglandi *Bonaparte*
(*White-winged scoter*)
Oidemia perspicillata (*Linnaeus*)
(*Surf scoter*)
Erismatura jamaicensis (*Gmelin*)
(*Ruddy duck*)
Chen hyperborea hyperborea (*Pallas*)
(*Lesser snow goose*)
Chen hyperborea nivalis (*Forster*)
(*Greater snow goose*)
Chen caerulescens (*Linnaeus*)
(*Blue goose*)
Anser albifrons gambeli (*Hartlaub*)
(*American white-fronted goose*)
Branta canadensis (*Linnaeus*)
(*Canada goose*)
(*Hutchins goose*)
Branta canadensis hutchinsi (*Richardson*)
Branta bernicla glaucogastra (*Brehm*)
(*Brant*)
Branta nigricans (*Lawrence*)
(*Black brant*)
Branta leucopsis (*Bechstein*)
(*Barnacle goose*)
Olor columbianus (*Ord*)
(*Whistling swan*)
Olor buccinator (*Richardson*)
(*Trumpeter swan*)

Order **Herodiones**
Herons

Family **Ibididae**
Ibises

Guara alba (*Linnaeus*)
(*White ibis*)

Plegadis autumnalis (*Hasselquist*)
(*Glossy ibis*)
Plegadis guarauna (*Linnaeus*)
(*White-faced glossy ibis*)

Family **Ciconidae**
Storks
Mycteria americana *Linnaeus*
(*Wood ibis*)

Family **Ardeidae**
Bitterns and Herons
Botaurus lentiginosus (*Montagu*)
(*American bittern*)
Ixobrychus exilis (*Gmelin*)
(*Least bittern*)
Ixobrychus neoxenus (*Cory*)
(*Cory least bittern*)
Ardea herodias *Linnaeus*
(*Great blue heron*)
Herodias egretta (*Gmelin*)
(*American egret*)
Egretta candidissima (*Gmelin*)
(*Snowy heron*)
Hydranassa tricolor ruficollis (*Gosse*)
(*Louisiana heron*)
Florida caerulea (*Linnaeus*)
(*Little blue heron*)
Butorides virescens (*Linnaeus*)
(*Green heron*)
Nycticorax nycticorax naevius (*Boddaert*)
(*Black-crowned night heron*)
Nyctanassa violacea (*Linnaeus*)
(*Yellow-crowned night heron*)

Order Paludicolae

Family **Gruidae**
Cranes
Grus americana (*Linnaeus*)
(*Whooping crane*)
Grus mexicana *Müller*
(*Sandhill crane*)
Rallus elegans *Audubon*
(*King rail*)
Rallus crepitans *Gmelin*
(*Clapper rail*)
Rallus virginianus *Linnaeus*
(*Virginia rail*)
Porzana carolina (*Linnaeus*)
(*Sora*)
Coturnicops noveboracensis (*Gmelin*)
(*Yellow rail*)
Creciscus jamaicensis (*Gmelin*)
(*Black rail*)
Crex crex (*Linnaeus*)
(*Corn crake*)
Ionornis martinica (*Linnaeus*)
(*Purple gallinule*)
Gallinula galeata (*Lichenstein*)
(*Florida gallinule*)
Fulica americana *Gmelin*
(*American coot*)

Order Limicolae

Plover, snipe, etc.

Family **Phalaropidae**
Phalaropes
Phalaropus fulicarius (*Linnaeus*)
(*Red phalarope*)
Lobipes lobatus (*Linnaeus*)
(*Northern phalarope*)
Steganopus tricolor *Vieillot*
(*Wilson phalarope*)

Family **Recurvirostridae**
Avocets
Recurvirostra americana *Gmelin*
(*American avocet*)

Family **Himantopodidae**
Stilts
Himantopus mexicanus (*Müller*)
(*Black-necked stilt*)

Family **Scolopacidae**
Snipe etc.
Scolopax rusticola *Linnaeus*
(*European woodcock*)
Philohela minor (*Gmelin*)
(*American woodcock*)
Gallinago delicata (*Ord*)
(*Wilson snipe*)
Macrorhamphus griseus (*Gmelin*)
(*Dowitcher*)
Macrorhamphus scolopaceus (*Say*)
(*Long-billed dowitcher*)
Micropalama himantopus (*Bonaparte*)
(*Stilt sandpiper*)
Tringa canutus *Linnaeus*
(*Knot*)

Arquatella maritima (*Brünnich*)
(*Purple sandpiper*)
Pisobia maculata (*Vieilott*)
(*Pectoral sandpiper*)
Pisobia fuscicollis (*Vieillot*)
(*White-rumped sandpiper*)
Pisobia cooperi (*Baird*)
(*Cooper sandpiper*)
Pisobia bairdi (*Coues*)
(*Baird sandpiper*)
Pisobia minutilla (*Vieillot*)
(*Least sandpiper*)
Pelidna alpina alpina *Linnaeus*
(*Dunlin*)
Pelidna alpina sakhalina (*Vieillot*)
(*Red-backed sandpiper*)
Erolia ferruginea (*Brünnich*)
(*Curlew sandpiper*)
Ereunetes pusillus (*Linnaeus*)
(*Semipalmated sandpiper*)
Ereunetes mauri *Cabanis*
(*Western sandpiper*)
Calidris leucophaea (*Pallas*)
(*Sanderling*)
Limosa fedoa (*Linnaeus*)
(*Marbled godwit*)
Limosa haemastica (*Linnaeus*)
(*Hudsonian godwit*)
Totanus melanoleucus (*Gmelin*)
(*Greater yellow legs*)
Totanus flavipes (*Gmelin*)
(*Lesser yellow legs*)
Helodromas solitarius (*Wilson*)
(*Solitary sandpiper*)
Catoptrophorus semipalmatus (*Gmelin*)
(*Willet*)
Catoptrophorus semipalmatus inornatus *Brewster*
(*Western willet*)
Pavoncella pugnax (*Linnaeus*)
(*Ruff*)
Bartramia longicauda (*Bechstein*)
(*Bartramian sandpiper*)
Tringites subruficollis (*Vieillot*)
(*Buff-breasted sandpiper*)
Actitis macularia (*Linnaeus*)
(*Spotted sandpiper*)
Numenius americanus *Bechstein*
(*Long-billed curlew*)
Numenius hudsonicus *Latham*
(*Hudsonian curlew*)
Numenius borealis (*Forster*)
(*Eskimo curlew*)
Numenius arquatus (*Linnaeus*)
(*European curlew*)

Family **Charadriidae**
Plovers

Vanellus vanellus (*Linnaeus*)
(*Lapwing*)
Squatarola squatarola (*Linnaeus*)
(*Black-bellied plover*)
Charadrius dominicus *Müller*
(*American golden plover*)
Oxyechus vociferus (*Linnaeus*)
(*Killdeer*)
Aegialitis semipalmata (*Bonaparte*)
(*Semipalmated plover*)
Aegialitis meloda (*Ord*)
(*Piping plover*)
Ochthodromus wilsonius (*Ord*)
(*Wilson plover*)

Family **Arenariidae**
Turnstones

Arenaria interpres morinella (*Linnaeus*)
(*Ruddy turnstone*)

Family **Haematopodidae**
Oyster catchers

Haematopus palliatus (*Temminck*)
(*American oyster catcher*)

Order Gallinae
Gallinaceous birds

Family **Odontophorinae**
American partridges, quails

Colinus virginianus (*Linnaeus*)
(*Bobwhite*)

Family **Tetraonidae**
Grouse

Canachites canadensis canace (*Linnaeus*)
(*Canada grouse*)
Bonasa umbellus umbellus (*Linnaeus*)
(*Ruffed grouse*)

Bonasa umbellus togata (*Linnaeus*)
(*Canadian ruffed grouse*)
Lagopus lagopus (*Linnaeus*)
(*Willow ptarmigan*)
Tympanuchus cupido (*Linnaeus*)
(*Heath hen*)
Lyrurus tetrix (*Linnaeus*)
(*Black grouse*)
Tetrao urogallus *Linnaeus*
(*Capercaillie or Capercailzie*)

Family **Phasianidae**
Pheasants
Phasianus colchicus *Linnaeus*
(*English pheasant*)
Phasianus torquatus *Gmelin*
(*Ring-necked pheasant*)

Family **Meleagridae**
Turkeys
Meleagris gallopavo silvestris (*Vieillot*)
(*Wild turkey*)

Order **Columbae**
Family **Columbidae**
Pigeons
Ectopistes migratorius (*Linnaeus*)
(*Passenger pigeon*)
Zenaidura macroura carolinensis (*Linnaeus*)
(*Mourning dove*)
Columbigallina passerina terrestris *Chapman*
(*Ground dove*)

VI
HISTORICAL MUSEUM

In my report of last year was published a statement setting forth the propriety of the establishment of a State historical museum, the statutory authority of the Regents of the University to inaugurate and uphold such an undertaking and outlining a logical plan for such a museum. The proposition as therein stated was submitted to the Regents committee on the State Museum and with their unanimous approval laid before the Board which also unanimously

Voted, That the report of the committee be adopted and that the Commissioner of Education be authorized to direct the establishment of such a State Historical Museum through the Director of the State Museum.

Following this favorable action the general plan of the proposed historical museum was embodied in a circular and distributed very widely throughout the State to all historical associations and to a large number of individuals interested either locally or generally in the history of the State. The response to this circular was general, cordial and even enthusiastic. It has been evident from the first that the successful outcome of this project would depend less on an approving sentiment than on actively contributing participation, particularly in view of the fact that it has been distinctly not the purpose to ask special appropriations, but to carry the undertaking along with present means so far as these could

be made available. It is fully realized that such a collection must grow slowly and it is not hoped to reach with a leap the end aimed at. The owners of historical relics throughout the State, seeking to dispose of them in such a way as to guarantee their care and perpetuate their associations, will make them of greatest use to the public by depositing them with the museum.

In the execution of the plan it has seemed wise to begin at the beginning, with our aboriginal culture wherein there is a logical and working connection with the past and present operations represented by the section of Archeology. It is eminently proper that the remarkable achievement of the Iroquois Confederacy, which affords a unique example of native culture and democratic polity, should be conserved and reportrayed as fully and as effectively as it is now possible to do. The general scheme for such an Iroquois collection involves:

1 The assembling in proper association of the relics of the Iroquois nation now or to be in the possession of the State.

2 The preparation of a series of life-size groups of figures expressing the various phases of the domestic, industrial and military life of the native tribes, with careful detail as to costumes, accessories and scenery, the work to be executed by expert artists and craftsmen and the models cast from the best living types. Each of these groups, of which six are now planned, would contain five or more life figures and have a front length of 15 to 20 feet.

3 A series of busts, mounted on suitable pedestals, of typical Iroquois heads, one of each of the Six Nations.

It is very agreeable and encouraging to be able to record a substantial evidence of private interest in this public undertaking. Mrs Frederick F. Thompson of New York, a daughter of former Gov. Myron H. Clark, has given the sum of $15,000 for the execution of this plan for an Iroquois collection, which on its completion is to be known as *The Myron H. Clark Museum of Iroquois Culture.*

Work on the preparation of this collection has begun, the models are being assembled and the sculptor to execute the casts is engaged.

VII

ARCHEOLOGY

Field work in archeology began in May when certain localities in Essex, Warren and Clinton counties were visited to determine the availability of the sites. A number of interesting sites of former Algonquin occupancy were examined in the vicinity of

Plate 5

High Banks site, near Irving, N. Y. The view shown in the photograph is of the northeast end. The village site is 750 feet to the right (southwest).

Plattsburg. At Dresden, Washington co., a camp site was discovered and excavated, about 150 specimens of pottery and flints being collected.

In June investigations were made in Madison and Onondaga counties. Fifteen sites in the Pompey group were examined and six near the Madison-Onondaga county line. All of the sites mentioned indicated that they had been dug into from time to time during a period of more than 50 years and the specimens that were found have been scattered.

On June 22 work was commenced on the High Banks site a mile and a half from Lake Erie on the Cattaraugus creek in the Cattaraugus Reservation, Erie county. The High Banks site[1] is an interesting one archeologically and several collectors have endeavored to lease it for excavation. It is situated on a natural knoll perched upon the edge of the alluvial bluff that overlooks the Cattaraugus valley. It is a spot well adapted for fortification or refuge. At the base of the bluff are copious springs. An old trail runs down the steep bank to the flood plain of the creek but at its lower end has been washed away by the stream. A swale is yet visible along the bottom of the bluff and is plainly an old arm of the stream now 2000 feet to the southwest. From the top of the bluff human bones, pottery and old refuse material have fallen out with each spring's landslide and the old inhabitants tell of a large number of skeletons which rolled down the bank during 1881 to 1885 when a rapid current from the creek ran through the swale and undercut the bank.

Excavation soon revealed that the knoll top was covered only by a village soil layer, there being no burials. Postholes were dug over an area of five acres about the knoll for burials but none could be discovered. The top of the knoll was covered by five large refuse heaps, presumably the kitchen refuse of as many lodges. These refuse heaps and the ground about them were excavated with great care and more than 600 good specimens taken therefrom. These artifacts are familiar types of pottery, bone and antler implements and ornaments, polished stone objects, chipped stones, cut brass, worked iron, shell articles, glass beads and fragments of European pottery. There are also a number of articles

[1] The High Banks site is situated on the farm of the late Ruth Stephenson. Ruth Stephenson was Red Jacket's stepdaughter and Red Jacket's bones rested in her house for some time before their reinterment in Forest Lawn, Buffalo. The Indians have several legends about the site and still regard it with superstition.

made from fossils. A detailed list of the articles discovered in the lodge refuse heaps may be found in the list of accessions.

An examination and comparison of these articles points out their manufacture by the Senecas. They are similar in every way to Seneca articles from central New York of the period 1654–1779. They are so dissimilar to types known to be Erie and Neutral that even though the site is on reputed Erian territory, their Seneca origin is apparent.

The Archeologist's examination of this site as well as many others in the region of the Cattaraugus valley only confirms the conclusion that the Senecas occupied the valley some time after the Erie war in 1654.

In plate 11 a number of pipes are illustrated; that these pipes are not Erian but Senecan is at once apparent to those familiar with the two types.

Mouth of the Cattaraugus site. An old site at the mouth of the Cattaraugus creek was examined with some interesting results. Few ash pits could be discovered and the site seems to have belonged to some Preiroquoian culture. There was no pottery to be found but notched arrow points and knives were common on the surface, as also were celts; gorgets have also been found here.

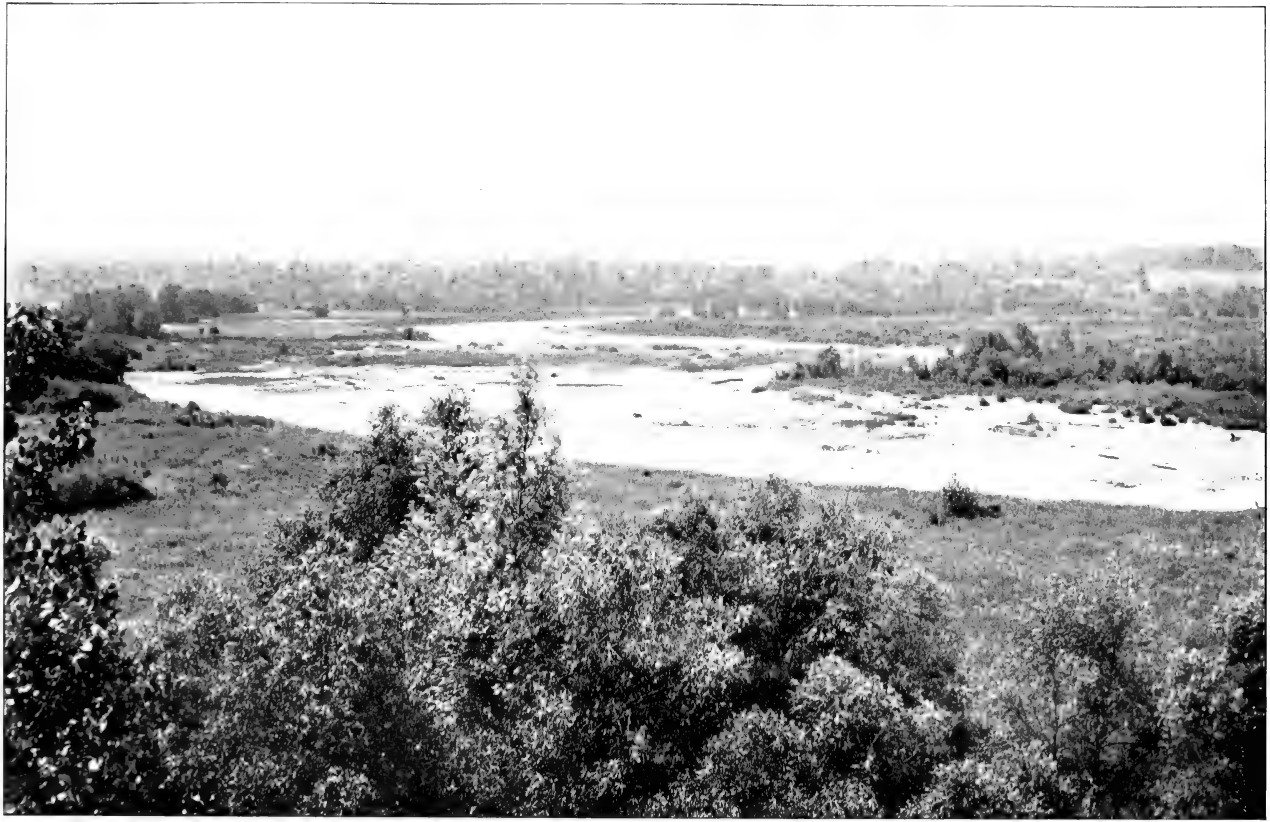
Excavations in this site as well as in other places point out the early occupancy of this region by a Preiroquoian people, presumably some early Algonquin branch familiar with soapstone pots but unacquainted with pottery.

Several sites along the shore of Lake Erie indicate also a later Algonquin people familiar with pottery. A good example of such a site is the crescentric earthwork near Sheridan, Chautauqua co.

From the site at the mouth of the Cattaraugus were found over a hundred flints of various colors. The material is similar to that from Ohio.

Central New York sites. A number of interesting sites were examined in Monroe, Ontario and Livingston counties. Many of the places in this region have been excavated by local collectors, but a number are yet available. Where such a general interest prevails in archeology, the activity of collectors in excavating the sites in this neighborhood has lessened the number of sites available to archeologists from museums. Hundreds of sites in the Genesee valley have been opened and a great wealth of material taken out. Nearly a month was spent in the vicinity of West Rush, Monroe co. and more than 20 sites examined for future

Plate 6



View of the Cattaraugus valley from the High Banks village site. On the Chautauqua hills in the background are several Preiroquoian village sites and forts and several early Iroquoian sites. The modern sites are all on the Erie county side, that in the foreground. The creek waters in this picture are low. High water covers all low points and frequently floods the fields.

Plate 7

The southwest end of the Silverheels site. The graves were found near the top of the point. Some of the objects found here are shown in plates 10 and 12

Plate 8

Mouth of the Cattaraugus site. The site lies several hundred feet back from the shore of Lake Erie. The mouth of the creek is shown in the right background

investigation. Several hundred specimens of pottery, flint objects, shell and bone articles and skeletons were collected in this region.

Silverheels site. This site is situated a half mile from High Banks up the Cattaraugus. Here in 1903 the Archeologist with Mr M. R. Harrington opened more than 50 Indian graves and secured a fine collection of pottery and other objects for the Peabody Museum of Archeology and Ethnology. The manager of the farm upon which the site is located forbade further excavation, thinking the relics of great commercial value. During the spring of 1908, however, the Archeologist secured a good collection of objects from the site, notably 2 pottery vessels, 2 pipes, a fragment of a rush basket, a *Towisas* tortoise rattle, a bone comb, a stone charm, otter effigy, a gourd cup preserved by contact with copper, etc. All the pottery from the Silverheels site is Senecan, and not Erian, in form and ornamentation.

Ripley site. Some additional excavations were conducted at Ripley under the direction of the Archeologist, by Mr Everett R. Burmaster, a field assistant. Mr Burmaster opened several graves in a portion of the site where burials had not been hitherto found. Among the valuable specimens are several crushed pottery vessels, a fragmentary turtle-shell rattle, a bone comb, bone beads and several skeletons. The bone comb is of the early fork type and has three teeth only. The turtle-shell rattle was plainly visible in the grave and contained a handful of gravel stones. When taken up the carapace fell apart. This object is of considerable interest in the light of comparative studies.

Pottery restoration. Many of the finest types of pottery vessels found in graves and ash pits are crushed into a number of fragments. Some specimens taken out embrace 20 pieces and others 100 or more. Pottery in this condition is interesting, but far more so if the fragments are cemented together and the vessel restored. The work of restoring pottery vessels has been carried on by Mr Martin Sheehy who, by exercising great patience, has restored more than 20 vessels from the Ripley, Gerry and High Banks sites.

Public interest. The large number of letters of inquiry received from this as well as other states indicates a keen interest in matters pertaining to New York Indians. The range of inquiry has covered almost every feature of the Indian culture, language, folklore, ceremonies, costumes, customs, arts, industries, textiles, ornaments etc.

A large number of collectors have visited the Archeologist's laboratory bringing with them specimens for opinion and identification.

Publications. During the early part of the fiscal year the Archeologist spent some time in editing and annotating the *Myths and Legends of the New York State Iroquois*, collected by the late Mrs Harriet Maxwell Converse. Some 133 printed pages were added to the original manuscript which covered only 50. This work, issued as Museum bulletin 125, has been received very favorably by the press and by those interested in Iroquois ethnology. With the Iroquois themselves it is regarded most favorably, which is perhaps the best possible recommendation.

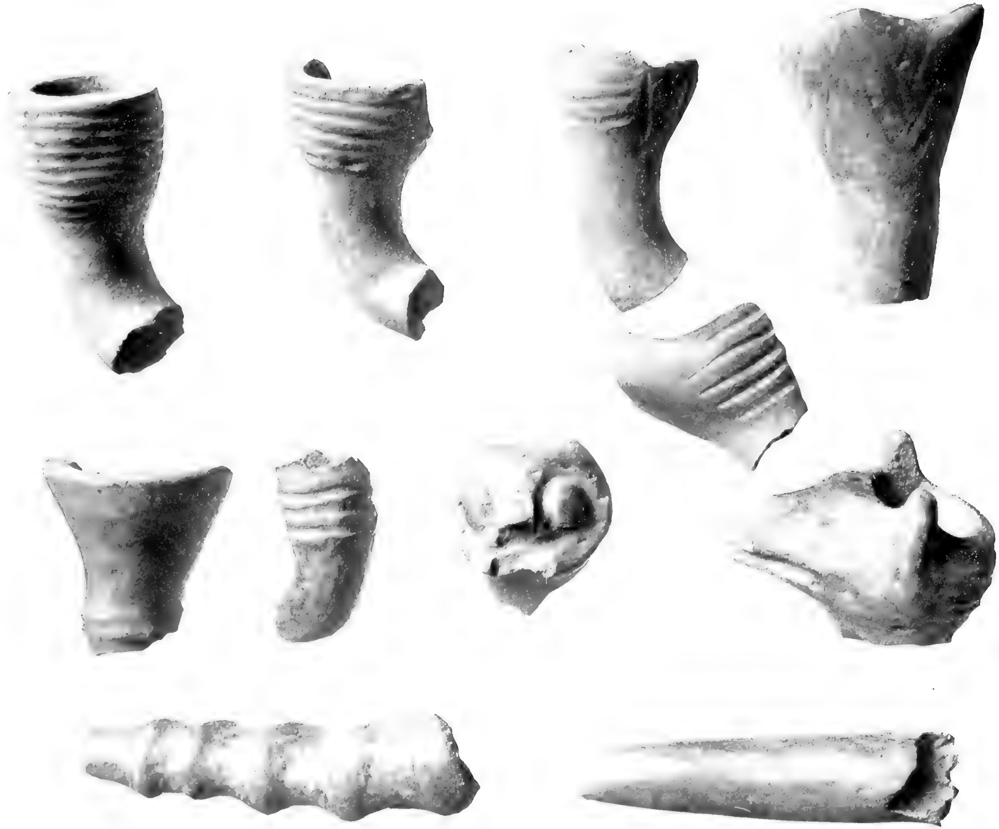
Frauds. The Archeologist wishes to caution museums and collectors against fraudulent specimens from Chautauqua, Erie, Cattaraugus and Onondaga counties, where such articles have been offered for sale. In Chautauqua, Erie and Cattaraugus counties the Archeologist has examined three collections containing imitations of stone implements, some of which have incised pictographs. Several frauds from the Cattaraugus Reservation are Indian made without a doubt but are of quite modern manufacture. A number of bowl shaped "mortars" in Monroe county were originally made by a blacksmith 30 or 40 years ago for water vessels to be used in poultry yards. Stone molds for mill machinery have also been mistaken for Indian relics.

ETHNOLOGY

Progress in ethnological research has been specially satisfactory and many valuable objects have been acquired. These accessions include clothing, hunting implements, ceremonial objects, basket maker's outfits, a silversmith's outfit, silver ornaments and a burden strap in process with all the fabrics necessary for its completion.

The great scarcity of ethnological material on the New York reservations makes it difficult to add much to our collections from that source. Private collectors and museums have the great bulk of Iroquois artifacts, save those which are buried in their old villages. The Iroquois have lost many of their ancient arts, and most of their old-time costumes and ceremonial paraphernalia have been taken by collectors. The Indians have done little in the way of replacing these articles. Most of the ethnological specimens purchased this year, however, were obtained from the Indians themselves. An especially noteworthy addition is the silversmith's outfit. In the Archeologist's paper on *The Silverwork of the Iroquois* the following description is found:

Plate 9

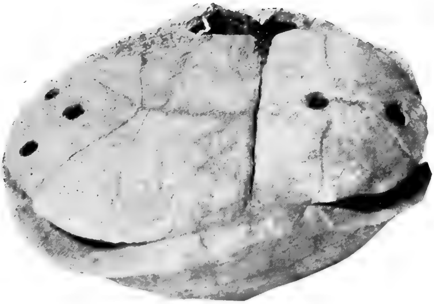


Types of pipe bowls and stems from High Banks site. Collected 1908

Plate 10

Pottery vessels from the Silverheels site, near Irving, N. Y. Collected 1908

Plate 11



1

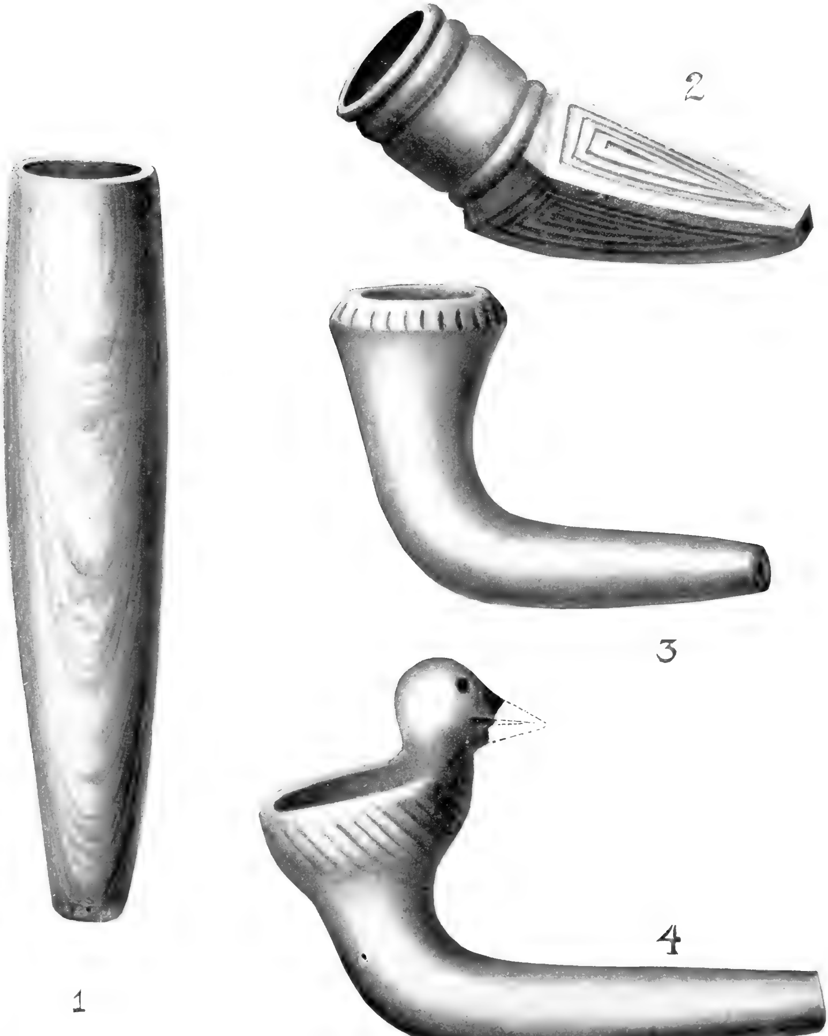
2

3

4

Objects from graves near Irving, N. Y. 1 Tortoise rattlebox such as is used by the Seneca Towiisas Society. 2 Bone comb. 3 Small gourd and rattle. The gourd has been preserved by contact with the brass rattle. 4 Small brass kettle

Plate 12



Types of pipes of four succeeding occupations in Erie and Chautauqua counties. 1 Early form from mound. 2 Early form of pottery pipe from early Iroquoian (?) culture. 3 Erie clay pipe. 4 Seneca pipe of clay

SENECA SILVERSMITH'S TOOL OUTFIT

During the autumn of 1907 the writer was informed by a number of Indians from the Allegany Reservation that there was a silversmith's outfit of tools in the possession of Silversmith George, an old Seneca Indian living near Tunesassa on the Allegany river. Knowing the extreme rarity of such tool kits an immediate effort was made to secure it. Smith George was visited and the outfit purchased for a few dollars. It was incomplete but at the time the State Museum had not a single Indian silverworker's tool. As much information was obtained as could be imparted by Mr George, whose deceased brother had been the real skilled worker. During the summer of 1908 another outfit was located on the Cattaraugus Reservation. It was in the possession of Mrs Nancy Mohawk and was purchased through the good offices of Chief Delos Big Kittle, known to his fellow tribesmen as Chief Soinowa. This outfit was complete except for the brass patterns which had been loaned to a son in law. It was promised that they would be restored for a few dollars more and added to the outfit already in hand.

The outfit as it stood consisted of an old stained pine table with a drawer which had been partitioned off to contain the various tools which consisted of more than a hundred chisels, several homemade saws fashioned from case knives, a blow pipe, a candlestick, hammers, pinchers, a small table vise, punches, dies, awls, gravers, files etc., and several boxes of silver cuttings, chips, brooches in process, earrings in process, glass in various stages of the shaping process for mounts etc. A small partition contained several flint drills and a flint graver, also eight pieces of flat deer bone in process of manufacture into gaming buttons.

As in the case of the outfit secured on the previous year as many data as the Indian owners could furnish, prompted by vigorous questioning, were secured. Questions which might suggest answers were not asked in any instance, this being a better method to employ when interrogating Indians unaccustomed to analytical studies, and who many times will acquiesce to a suggested reply.

The outfit purchased from Mrs Mohawk, according to her statement, once belonged to Chief Tommy Jemmy, who was once tried for murder in Buffalo, his offense being the execution of a witch in accord with the national laws of the Seneca Indians. His defense by Red Jacket was a masterpiece of eloquence and a stinging rebuke to meddlers with Indian affairs who teach Indians a thing one moment and punish them the next for following that teaching. Red Jacket's philippic is now one of the classics of Indian oratory. Jemmy's silversmithing tools passed to his descendants and finally to Mrs Mohawk.

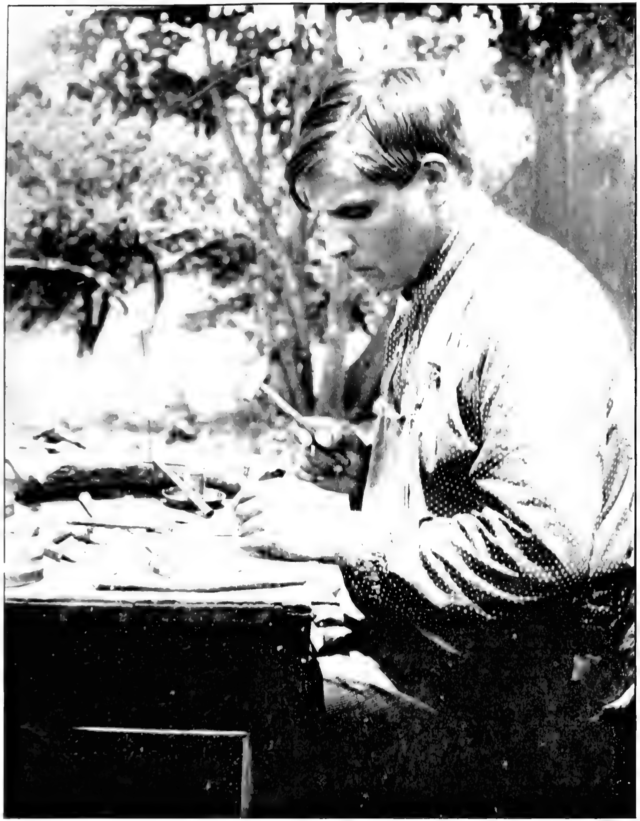
A number of photographs were taken showing the uses of the various tools. Several experiments were conducted in die stamping, graving and melting silver by blowpiping a candle flame upon the metal held in the hollow in a piece of hard wood. The silver melted, fused and with the withdrawal of the flame hardened into a small button.

Origin of Iroquois silversmithing. A few additional notes from the Archeologist's paper previously mentioned will be found of immediate interest.

Iroquois silversmithing and silver work are subjects worthy of the attention of ethnologists. Silver brooches are among the most sought for of the later day products of Iroquois art. Beauchamp, Converse and Harrington have each interesting accounts of the brooches but none of them has indicated how the Iroquois first obtained their knowledge of silver working or have suggested how the patterns of the most common forms were secured. Mrs Converse wrote "I fail to find in illustrations of jewelry ornamentation of either the French, English or Dutch, designs that have been actually followed in the hammered coin brooch of the Iroquois." Harrington remarks in his excellent paper, the best yet issued on the subject, "Before concluding, a few words concerning the art of silversmithing among the Iroquois may not be out of place. Of course such a discussion must necessarily be almost entirely theoretical. Taking the brooches first, it seems possible that we may look for their ultimate origin in the ornaments of copper, mica and other materials, thought to have been sewed or tied upon garments as ornaments by many tribes of the precolonial period. As Beauchamp says, 'Apparently the brooch was the evolution from the gorget for some (early) ornaments of this kind were tied on, not buckled.' He mentions and figures such a crude broochlike ornament of copper found on an Onondaga site of 1677. It is difficult to surmise how the buckle tongue fastening originated, or if borrowed whence it came. Perhaps the idea was in some way derived from the old-fashioned shoe or belt buckle of the colonists. Examining the patterns, the Masonic type speaks for itself, as being clearly of European origin; but other forms are not so easily traced. The heart type surmounted by an apparent crown looks suspiciously European also; but we can not prove that the heart, which occurs so often in all kinds of Iroquois carving and bead work, is not a pattern native to the people. The crown-shaped ornament above possibly represents a feathered headdress, or sometimes an owl's head. . . "

The Archeologist became interested in Indian silver ornaments in his early boyhood when he associated with other Seneca boys on the reservation. His mother, Mrs Frederick E. Parker, was fortunate enough to secure a large collection of the silver brooches, known to the Indians as *ĕnius'-kä,* which was exhibited at the Buffalo International Exposition in 1888. Many of the rarer forms from this collection with two of the Governor Blacksnake wampum belts were given later to Mrs H. M. Converse and are now in the New York State Museum. Subsequently the Archeologist collected a large number of brooches which he added to the above mentioned

Plate 13



A Seneca silversmith at his work bench. The silversmith is cutting out a star-shaped brooch.

A Seneca silversmith at his work bench. Melting a lump of silver by blowpiping a candle flame upon the silver which lies in the hollow of a wooden block

collection. After his appointment as Archeologist of the State Museum his studies of Iroquois silver work were continued and during the past two years more than a hundred specimens of the silver worker's art have been added to the State Museum collections. With the acquisition of the silversmiths' outfits previously mentioned, the question of the origin of the brooches was taken up along different lines. Several clues were followed. One important suggestion was given by some illustrations of circular brooches from burial mounds in Great Britain. Another important clue was furnished by a friend who had visited the museums in Scotland.

In order to clear up the matter the following letter was written to Dr Joseph Anderson, Curator of the National Museum of Antiquities of the Society of Antiquaries of Scotland, in Edinburgh:

New York State Museum
Albany, N. Y., December 2, 1908

Dr Joseph Anderson, Curator
National Museum of Antiquities
Edinburgh, Scotland

My dear sir: The Indians of New York State for two hundred years have made, with their native tools, articles of silver, known as Indian brooches, which in some respects are similar, I am told, to buckles and brooches which have been used in Scotland for centuries. I am sending you, herewith, a pamphlet describing the Indian ornaments and should be greatly obliged if you would let me know, by referring to the plates and numbers, which are similar to Scotch forms. Any literature or photographs which you have describing the articles in question would be most welcome to me.

I am preparing a monograph on Iroquois Indian silver work for our museum and any information you may give will be gratefully acknowledged.

Very sincerely
[*Signed*] Arthur C. Parker
Archeologist, New York State Museum

In reply to this inquiry, Dr Anderson wrote:

Society of Antiquaries of Scotland
National Museum of Antiquities
Queen Street, Edinburgh, Dec. 15th, 1908

Dear sir: In reply to your note as to the silver brooches made by the Iroquois Indians, I think that nearly all of those figured in the plates of the pamphlet you kindly sent me are imitations and adaptations of the Scottish Luckenbooth brooches, so called because they were chiefly sold in the Luckenbooths around about St Giles's Church, Edinburgh. This applies to all those modeled on the

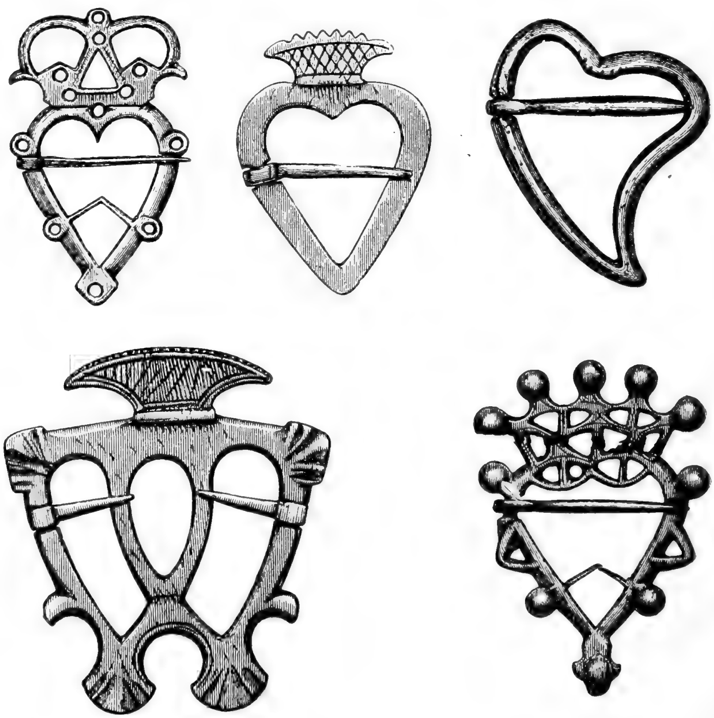
design of a single or double heart, crowned, and also to the simpler forms of a heart alone. The Masonic badges seem also to be imitated from originals, but they need not necessarily have been Scottish.

I enclose a short note by a former fellow of this society, Robert Sheills of Neenah, Wisconsin, which gives some curious facts that tend to explain the widespread dissemination of these brooches from the old country among the Indian allies of the British both in Canada and the States. I also add a page of our museum catalog on which some of the Scottish specimens of the Luckenbooth brooches are figured.

Yours very truly
[*Signed*] JOSEPH ANDERSON

To Arthur C. Parker
New York State Museum
Albany, N. Y.

The inclosure in this letter illustrating the Scotch Luckenbooth brooches is reproduced herewith. The leaves from the *Proceedings of the Society of Antiquaries of Scotland,* February 12, 1900, pages 220, 222, sent as an inclosure with the letter contain the following record:



Scotch Luckenbooth brooches

1 By Robert Sheills, F.A.A. Scot., Neenah, Wisconsin, United States of America.

Indian socketed spearhead or knife of native copper, 4½ inches in length by 1⅛ inches in breadth, from Neenah, Wisconsin.

Two *Luckenbooth brooches,* three small pendant crosses (of the shape shown in fig. 1), a circular mounting with five included circles and 11 small buckles all cut out of thin sheet brass, found together in excavating an Indian mound at Kaukauna, Outagamie co., State of Wisconsin.

Mr Sheills has supplied the facts for the following account of the locality and circumstances connected with the discovery of these curious relics of the old intercourse between the British and the Indians. Kaukauna is on the Fox river, 23 miles west of Green bay, which is one of the very oldest settlements in North America, at the south end of a large bay of Lake Michigan and the mouth of the Fox river. It was the seat of a Jesuit Mission and a depot for fur traders. The river was the highway to the Mississippi. Its sources are on the south side of the watershed of Lake Superior. It runs in a southerly course to the city of Portage, where it turns easterly to the bay. The Wisconsin river pursues a similar course to Portage, where a slight watershed deflects it westerly to the Mississippi. The two rivers come within three or four miles of each other and are now joined by a canal. The Indian traders used to take their canoes up the Fox river by Kaukauna and Neenah to Portage, carry them over the slight ridge, and go down the Wisconsin to Prairie du Chien on the Mississippi. Mr P. V. Lawson, ex-mayor of Manasha, has written an account of the circumstances in which these Luckenbooth brooches, crosses, and other trade articles came to be buried in the Indian mounds on this route. The method of obtaining the friendship of the Indian tribes during the occupation of the French and English was by making presents to the savages. By lavish gift making the British had the strong support of all the savage tribes of the northwest, even after the treaty of 1789, and up to and all through the War of 1812. From memoranda found in the Canadian archives it appears that there were given to a chief from the upper country, among other items: "three hundred brooches, twelve pair ear-bobs." By means of such gifts nearly every tribe in the great northwest fought on the British side.

A second letter of inquiry was sent to Dr Anderson, as follows:

New York State Museum

Albany, N. Y., December 29, 1908

Joseph Anderson, Esq.
National Museum of Antiquities
Edinburgh, Scotland

Dear sir: I have received your letter of the 15th inst., relative to the silver brooches made by the Iroquois Indians after the models of the old Scotch Luckenbooth brooches and am deeply

obliged to you for the information which you have furnished. There are several matters concerning these brooches upon which I should be glad to have you enlighten me.

First, what is the earliest record that you have of the manufacture of these brooches?

Second, for what purpose were they employed, that is, how worn upon the clothing?

Third, what distinctive names are given to the various types of these brooches respectively? The single heart and crown brooch I assume to be copies from the Douglass crest, but I am not so sure what name would be given to the double heart brooch, N. G. 44, page 359 of your catalogue.

Are there any sets of tools, dies and punches in your museum which were used by the makers of this silver work? I have collected several sets of these tools which were used by the Iroquois Indians for cutting out the brooches, so that there is no question that the Indians themselves imitated them. If you have any reference to old documents which tell of the distribution of these ornaments to the Indians in Canada and other British Indians in North America, it would be of material assistance to have a note of them.

Under separate cover I am sending you several bulletins of this museum which may interest you in your comparative studies.

Respectfully yours
[*Signed*] ARTHUR C. PARKER
Archeologist

Under date of Jan. 9th, 1909, Dr Anderson replied:

DEAR SIR: The earliest period for the manufacture of the heart-shaped and other shapes of the Luckenbooth brooches is a matter of inference, and may be 17th rather than 18th century. I do not know any record mentioning them specifically. The name, "Luckenbooth brooches," is an antiquary's invention, because they were sold in the stalls or Luckenbooths around St Giles's Church in the High street of Edinburgh. But they were not confined to Edinburgh or to the Luckenbooths there.

They were worn by women and children in the fastening of a bodice or collar or such part of dress. Being so made they were inserted for the fastening of thick stuffs.

There are no distinctive names given to the different types of these brooches, unless by descriptive phrases, such as heartshaped, crowned hearts, double hearts, crowned or not as may be, etc.

I do not think the brooches that partake of the heart shape were made in imitation of the Douglass crest, or have any relation to the family or traditions of the Douglasses. They were mostly used as love tokens, or betrothal gifts, and the choice of the heart shape or the crowned heart or the double heart for these purposes is sufficiently obvious. Moreover they frequently bear inscriptions, initials or posies, for instance on one in the museum is the inscrip-

Plate 14

Gushä'ä or burden strap in process of manufacture, showing colored moose hair, native hemp cord and basswood fiber. Collected by A. C. Parker

tion "Wrong not the —— whose joy thou art," the blank for the word heart being supposed to be supplied by the form of the brooch itself.

There are no sets of tools, dies or punches for making brooches, in the museum. I never saw or heard of any such.

Yours very truly
[*Signed*] JOSEPH ANDERSON

These letters and documents speak for themselves and leave us to infer either one of two things: First, The Indians furnished the idea for the brooches which were adopted by Europeans, the Scotch in particular, and the brooches were made in quantities in Scotland afterward and sent to America to be traded to the Indians; or, second, the Scotch, or other Europeans, carried them to America where they caught the fancy of the Indians who received them as gifts or in trade, and later manufactured them themselves. The second hypothesis seems more probable in the light of the evidence. There are few brooch patterns in the possession of collectors or museums. In every case within the writer's knowledge the majority of the patterns were lost or not accessible. An examination of some of the patterns indicates their manufacture by die cutting, the dies being true edged and geometrically perfect. The patterns which we are describing were not made with chisels used singly in cutting out the parts of the design, or if so the tools were of a character which might be expected to be found in the possession of a skilled jeweler. Through information given by the Director of this museum, the Archeologist has found that a set of die stamps had been in the possession of an Albany jeweler whose forebears also were jewelers and who sold many sets of patterns to the Indians in times past. A fuller description of these dies with a study of the Iroquois silversmithing art found in a paper by the Archeologist, *Silverwork of the Iroquois*.[1]

Seneca burden strap in process. During the autumn of 1903 when the Archeologist was engaged in archeological field work on the Cattaraugus Reservation, an old Indian informed him that he had a relic of interest which he had found in an old chest and which he wished to sell. The "relic" turned out to be a burden strap, gus'-ha, in an incomplete condition. The hemp card, the elm bark warp fiber and bundles of moose hair of various colors, were packed in the box with the "strap" and the entire process and materials of the weaving were made apparent. The peculiar part of the process is the fact that the belt is com-

[1] Manuscript prepared for publication in a museum bulletin on Iroquois Ethnology.

pleted in all its details as the weaving proceeds; that is to say, the weaving is not first completed and then the belt beaded and embroidered, but beading and embroidery are applied as the weaving proceeds. An examination of plate 14 where the belt and material are illustrated will make the meaning clear.

The burden strap was purchased from Peter Snyder for a New York collector who had at that time an interesting collection. Last winter the belt came into the possession of the State Museum where it forms a unique collection.

The story of the belt is, that it was started in 1811 by Hanging Kittle, into whose family Mary Jemison, the white captive, had been adopted. When Hanging Kittle died the belt was left incomplete, for reasons understood by the Indians, and more than a quarter of a century later it was wrapped up by a Mrs Snyder, a Seneca woman, and the grandmother of Peter Snyder who sold the belt. Peter said he had frequently heard the story of the belt which had been designed for his father who was to use it to carry venison from the Allegheny river hunting grounds to his home. The newspaper wrapping found about the strap was dated 1843.

Masks. Another series of articles of exceptional interest is the set of masks used by the Ie'i-'dos O-ä'-no or Society of Charm Keepers. These masks differ from those used by the False Face Company and are never used in the mask ceremonies. The Archeologist was fortunate enough to obtain several flashlight pictures of the society and will include them in a later report on the Animal Societies of the Iroquois.[1]

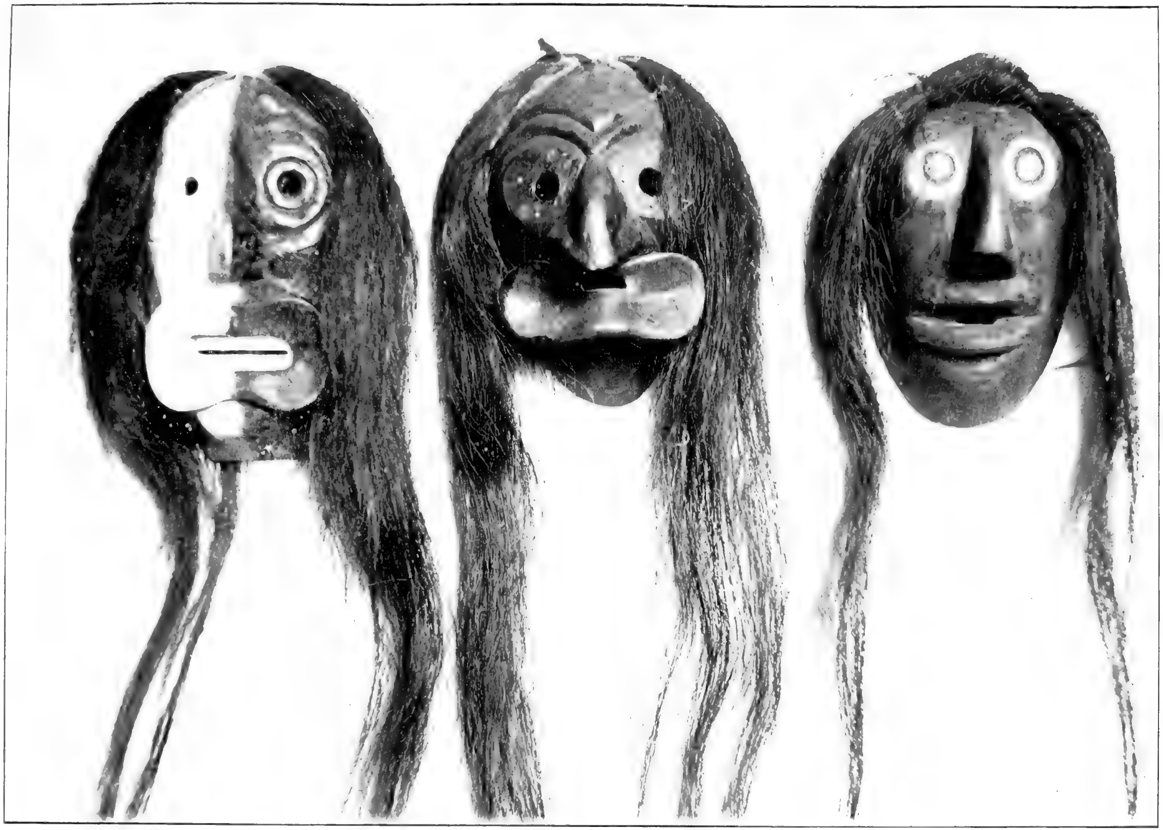
Folklore. Satisfactory progress has been made in the collection of myths and folk tales, 20 being recorded when attending the midwinter celebration in January 1908. Twelve good phonograph records were made of folk songs of unusual interest. This section now has a valuable collection of Seneca folk tales, and ceremonial texts.

Art and symbolism of the Iroquois. The study of the decorative art and symbolism of the Iroquois has been continued. Designs have been copied from many decorated Indian artifacts from New York State, belonging to the museum.

In plate 9 is shown a number of pattern designs taken from decorated rims of pottery vessels. The designs are typically Iroquois and as motifs for border decoration are not without value to art students and practical designers. The patterns are simple

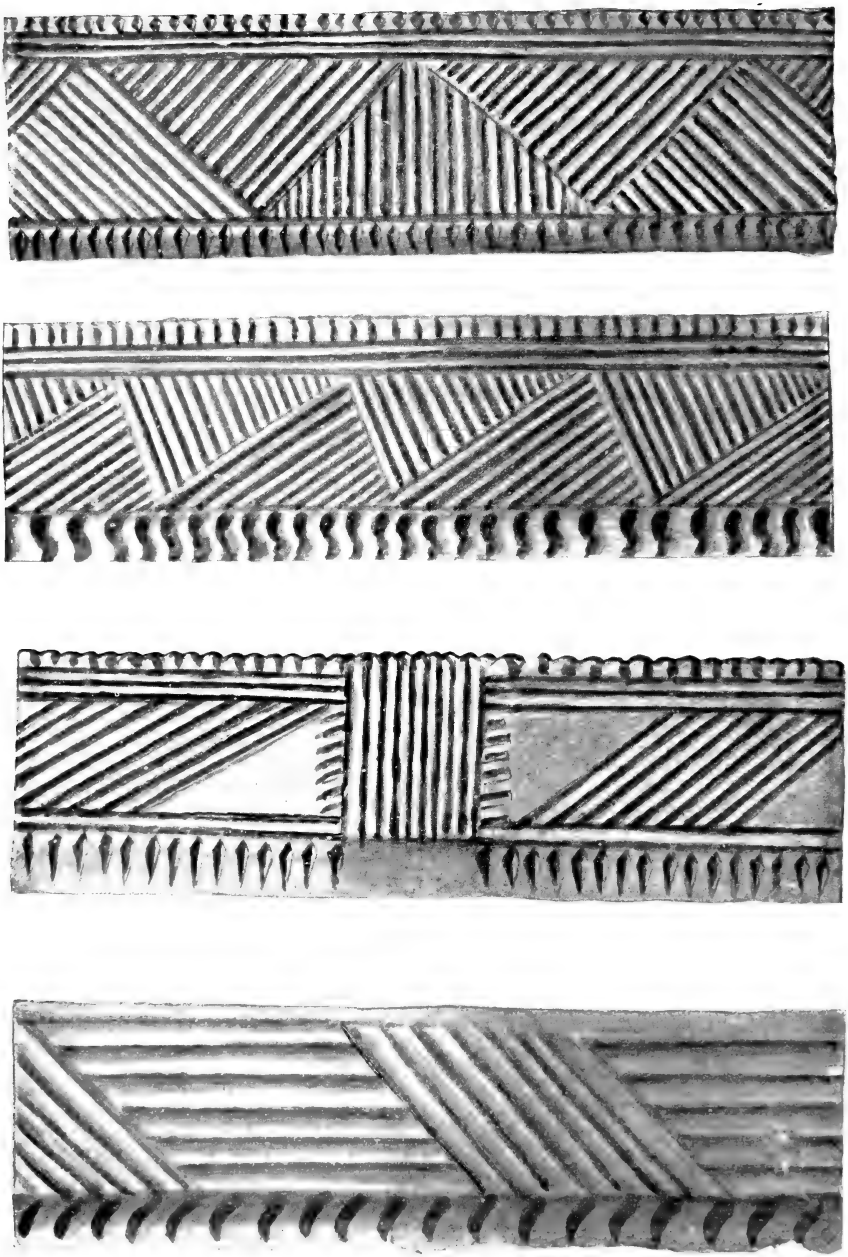
[1] *See also* Parker, A. C., Iroquois Medicine Societies. American Authropologist, July-Sept., 1909.

Plate 15



Masks used by the Ie'dos Company, a Seneca society. The third mask is used by the shaman who is reputed to be able to see through the wooden mask although it has no perforation for the eyes. This set of masks is the only one in any museum. These masks are not used by the False Face Company nor are they ever used in public ceremonies. Collection of 1908

Plate 16



Decorative motifs from Iroquois pot rims

in their composition, the technic is bold in its execution and the effect is striking without being offensive. In combining designs of straight lines such results are not easy to obtain and the success of the Iroquois designers in effecting such pleasing combinations is a tribute to their artistic skill.

Seneca societies

During the winter of 1904–5 the Archeologist made the discovery that many of the so called dances of the Iroquois, such as the Bear dance, the Bird dance or the Buffalo dance, were but public ceremonies of secret or semisecret societies. He has continued his studies of the rites of the native societies of the Iroquois, has translated many rituals, and recorded the ceremonial songs and chants on phonograph records.

Prefatory to his notes on the animal societies and other societies of the Senecas, the Archeologist makes the following observations which may be of some interest to those unacquainted with folk societies of aboriginal or primitive peoples:

Secret societies of the Senecas

The instincts and necessities of primitive man were similar to those of other animals. Self-preservation was the first instinct and all others were subordinate. In order to preserve himself it was necessary to obtain food. He destroyed animals for two purposes, that he might eat their flesh and that he might not be destroyed. Animals likewise sought men for food. Naturally this was not agreeable to man, being against his primal instincts. Man, being a thinking animal, able to compare, began to think whether it was not as disagreeable for beast animals to be eaten by men as for human animals to be eaten by beasts. An idea of this kind once implanted resulted in infinite development and gave rise to a great number of beliefs and customs.

Probably no people realized so fully that they were animals as "primitive man." He saw himself one of the species of animals among a host of others. But though he realized this, there was not a moment that he did not regard himself the superior animal and think that all others should be subservient to his wishes. At the same time he thought that beasts had rights that should be respected. He closely observed the beasts and learned whatever he could from them. He supposed that other animals were constituted mentally much as he. Observing their seeming display of intelli-

gence he thought some of them exceedingly wise, having access to knowledge of which he was ignorant. When he could not understand certain of their habits he was awed, and called them mysterious. He supposed animals capable of communicating one with the other and species with species. Indeed many circumstances seemed to point to the truth of this supposition until it became a fixed belief. If a man were unjust to animals they would communicate the fact to all other animals who would seek opportunity to revenge. If he were just and kind they would appreciate his goodness and give him "luck," warn him of danger and protect him in peril. The condition of primeval man and of his descendants who continued to live in the primitive way was one of continual danger. It was necessary for him to protect himself, his mate and his offspring from famine, from the attacks of animals, from the elements, from accidents and disease. The state of nature and the state of human society made his life one of continual struggle to accomplish these ends. Man, therefore, sought to eliminate all unnecessary dangers and to seek protection of any kind. Regarding animals as he did it was natural that he should have sought their good will and protection.

To primitive man dreams were oracles. Regarding himself as one of the animals or thinking animals mentally endowed as men are and living in close contact with animals, it is reasonable to suppose that savage man dreamed of ways by which he could secure the favor of animals, and, at the same time, dreamed what the wishes of animals were. Savage races are great dreamers and their dreams are in many ways different in character from those of civilized men. When primitive men dreamed, in many instances they felt bound to abide by the dictates of the dream. If they could not understand the vision, they consulted an interpreter of dreams. Desirous of the patronage of animals the dreamer would dream how to secure the favor of certain beasts or birds. In this manner may have originated personal totems and many customs.[1] As time went these dreams came to be related as actual experiences and were handed down as real happenings of the mysterious past. To the savage the past was always mysterious.

[1] Although "medicine men" versed in the lore of their people assert to those under their influence that the origin of certain customs and ceremonies as set forth in the legends are actually true, yet to outsiders they will sometimes admit that they originated in dreams. Esquire Johnson, the aged Seneca chief, whose relations are found elsewhere in the Archeologist's notes, said in an interview with Mrs. Asher Wright, "All the dances, feasts and other ceremonies originated in dreams."

Savage man thought more of holding the favor of animals than he did the good will of men in other communities than his own and for this reason was in certain things more considerate of beasts than men. He could slaughter whole tribes of men but unless certain animals were regarded as especially "bad medicine" he did not dare ruthlessly to kill them. Some animals were reputed more wise than others and came to be looked upon as "medicine animals." Such were thought to be able to protect man from the dangers of the elements, from accidents, and from diseases. In order to keep the favor of these animals it was necessary to perform certain rites and offer gifts. Since it was necessary to kill these medicine animals for food and for clothing there were ceremonies in which the permission of the animal was first sought before it was killed and afterward ceremonies of expiation

These primitive rites, ceremonies and customs have been held by the American aborigines for ages and even when tribes became in a degree civilized they were loath to abandon them. The Iroquois who have had three centuries of contact with the white man still cling to these ideas and among the Seneca-Iroquois of today there exist several "animal societies." Each has a well preserved legend setting forth its origin. Among the Senecas, who cling to their early beliefs, sickness and ill luck, famine and catastrophies of nature are supposed to be caused by witches, evil spirits or angry "medicine animals." Witches being "humans" are killed when discovered and there are many rites and charms for discovering witches and nullifying their machinations. With spirits and animals it is otherwise. Societies of remote origin hold formulas for driving away evil spirits and appeasing the *no-twai's-hä* or souls of the dead that are supposed to work evil. Societies for preserving the rites necessary to please animals and animal spirits rigorously enforce the laws relating to the pacification of the "medicine animals" and when the animals are made angry by neglect or insult they know the rites necessary to prevent calamity. Or, if they neglect the "spirit" to an extreme, and disease, pestilence, flood, famine or earthquakes result, they are still able to restore their good will.

Of these animal societies the following are still existent: the Eagle Society, the Otter Company, the Iē′′dos Company, the Pygmy Society, the Buffalo Society and the Bear Society. Other "medicine societies" are the Little Water Company, the O'gi′wē People, the Singers for the Dead, the False Face Company, and the Husk Face Band, and the To-wii′-säs, Sisters of the Dio-he′-ko.

Intellectually undeveloped men, as well as men of today, seek primarily the conditions which give their acquired or natural necessities, desires, inclinations, ideas and instincts the greatest comfort, freedom and satisfaction. In short, not only is freedom from antagonizing and destructive elements sought but pleasurable sensations also, the stimuli to coincide with both natural and acquired ideas. To attain these desired conditions the Iroquois like other races had their religion, their folk beliefs and their mystical societies.

A list of some of these societies with a very brief summary of their distinguishing features follows:

Nia-gwai' O-ä'-no, the Bear Society

1 The ritual of the Bear Society consists of 20 songs and a dance. At stages in the song and dance berry juice is drunk.

2 The ceremony is opened by offering tobacco incense to the spirits of bears. During this ceremony a speech is recited.

3 The sign of membership, or in other words the badge, is one black streak drawn diagonally on the right cheek.

4 The chief of the Bear Society is a woman.

5 The object of the society is to cure the diseases of its members or candidates by chanting its songs. The Bear song is believed to be a powerful remedy for fevers and rheumatism.

6 The chief woman blows on the head of the patient.

7 A person becomes a member of this society by dreaming that he or she must or by calling upon it for services.

8 No one but members may engage in its public dances.

9 After a ceremony the members depart bearing with them parts of bear pudding that had been cooked at the ceremony.

Sha-dot-gē'-a', the Eagle Society

1 The ritual of this society consists of 10 songs and a dance. The song is called *Ga-ne' gwa-a' O-ä-no* or the great eagle ceremony.

2 Every member engaging in a ceremony must paint each cheek with a round spot of carmine.

3 The Bird Society ceremony is considered as the most sacred next to the Great Feather dance.

4 It is believed that this society holds in its songs the most potent song charm known. It is said that the dying have been revived by it and completely restored.

5 No one but members may engage in its ceremonies.

6 A person may become a member by dreaming it necessary or by asking for its services.

7 Its membership is divided into two classes, the first, consisting of members belonging to the phratry of four greater clans and the second, of those belonging to the five lesser clans.

8 In its ceremonies, special costumes are worn and fans made of feathers held in the hand of each of the four dancers.

9 The Bird Society rattle is a small one made of a dried gourd, into which a dozen or so kernels of corn have been inclosed, and fitted with a wooden handle. Small bark rattles are used patterned after the bark false-face rattles.

10 In its public ceremonies each class of members is represented by two dancers, and two speakers.

11 The dancers dance in a squatting position.

12 During the ceremony any speaker desiring to make a speech strikes a striped pole held by the pole keeper and immediately the song, rattles, and dancers become silent. After a speech the speaker presents the dancers with a gift of bread or any other thing of which birds are fond.

13 Each speaker in his address upholds the clans which he represents and derides the others until the closing draws near when each apologizes for his derogatory remarks and begs to be pardoned.

14 In its private sessions the members feast on a boar's head.

15 Public ceremony of the Bird Society has only recently been the custom.

Ĭē''dos O-ä'-no, or Society of Mystic Animals

1 The ritual of this society consists of several score of songs and several dances.

2 The society is said to have been introduced among the Senecas by the western Iroquois-speaking people.

3 The principal ceremonies are:

a Gai-iu'' wĕn' o'go-wa

b Ga-ha-di-ya'' gon

c Gaï''-do

4 While chanting the rituals rattles of dried gourds are used exclusively for keeping time.

5 During the (*b*) and (*c*) ceremonies, mentioned above, only one member sings at a time.

6 The *Ĭē''-dos* is regarded as a strictly secret organization.

7 Its chief is said to be a man who is possessed of clairvoyant powers, being able to see through a wooden mask which has no openings and discover the ceremonial doll wherever it be hidden in the lodge. This chief is also able to juggle with fire while wearing his mask.

8 The ceremonies of the *Iē″dos* are said to be a cure for fever and skin diseases.

9 After the ceremonies the members feast on the head of a bear, the chief passing it around while each member tears off a mouthful with his teeth.

Additional notes on the Iē″dos Company

1 The Iē″dos Company is a band of "medicine" people whose object is to preserve and perform the rites thought necessary to keep the continued good will of the "medicine" animals. According to the traditions of the company these animals entered in ancient times into a league with them. The animals taught them the ceremonies necessary to please them and said that should these be faithfully performed they would continue to be of service to mankind. They would cure disease, banish pain, displace the causes of the disasters of nature and overcome ill luck.

2 Every member of the company has an individual song to sing in the ceremonies and thus the length of the ceremony depends on the number of the members. When a person enters the Iē″dos he is given a gourd rattle and a song. These he must keep with care, not forgetting the song or losing the rattle.

3 The head singers of the Iē″dos are two men who chant the dance song. This chant relates the marvels that the medicine man is able to do and as they sing he proceeds to do as the song directs. He lifts a red-hot stone from the lodge fire and tosses it like a ball in his naked hands. He demonstrates that he can see through a mask carved from wood and having no eyeholes by finding various things about the lodge. He causes a doll to appear as a living being and mystifies the company in other ways. It is related that new members sometimes doubt the power of the mystery man and laugh outright at some of the claims which he boasts. In such a case he approaches the doll and though his face be covered by a wooden mask cuts the string that holds its skirt on. The skirt drops exposing the legs of the doll. Then the doubting woman laughs for every one else is laughing, at the doll she supposes, but she shortly notices that every one is looking at her, and to

her utmost chagrin, discovers that her own skirt string has been cut and that she is covered only by her undergarments. Immediately she stops laughing and never afterwards doubts the powers of the medicine man, who when he cut the doll's skirt string by his magic power cuts hers also by magic.

The Iē″dos Company may be regarded as the first degree of the Secret Medicine Lodge; Little Water Company being known with the Dark dancers of the Pygmy Society as the Ho-no'-tci-no″-gä. This information was given by Chief Edward Cornplanter.

De-gi″-ya'-go^{n} O-ä-no, Buffalo Society

1 The ritual of this society consists of a number of songs which relate the story of its origin.

2 After a Buffalo ceremony each member carries away a portion of Buffalo pudding. (For receipt *see* "Corn and other vegetable foods of the Senecas.")[1]

De-wa-non-diis'-soñ-daik-to'. Pygmy Society (the Dark dance ceremony)

1 The ritual of this ceremony consists of 102 songs divided into four sections as follows: the first section, 15 songs; the second, 23 songs; the third, 30 songs; and the fourth, 34 songs.

2 The wet drum and horn rattle are used during this ceremony for keeping time.

3 The Dark dance is designed to propitiate certain spirits and to secure the beneficent offices of others, thus the ceremony is performed for appeasing the spirits of a charm that has become impotent or one which is feared, such as flying head's hair or *ni-a'′-gwa-hē′-s* tooth.

This ceremony also pleases the elves and secures their good will ("It is the religion of the Jo-gä′-o^{n}." Sainowa.) People who live near the reputed haunts of elves often order a Dark dance to cure certain ills that are thought to be punishments.

In order of importance the following "charms" are "members" of the society and are called *Ho-tci-ne' ga-dah,* Invisible aids.

1 Jo-gä′-o^{n}=pygmies
2 Jo-di‶-gwa-do″=great horned serpent
3 Shon-do-wĕk-o-wä=blue panther
4 De-wŭt-yo-wa-is= "explosive bird, like wren, explodes from hollow in tree." (Mythical)

[1] Bulletin in preparation.

Others of equal rank are:

5 Diat-da-gwŭt=white beaver
6 Oh-no-wa-ot-gont or Ga-ne′-ont-twŭt=corn bug
7 Ot-nä-yont=sharp legs animal, a mythical monster
8 O′-niä-ta=small dry hand
9 Da-gwŭn-no-yä-ent=wind spirit
10 Nia″-gwa-he=naked bear

The "charms" of these Ho-tci-no-gä kept by members are as follows: None of no. 1 or 2 "Because they are sacred and use their minds for a charm."

3 Panther's claw
4 Feathers
5 Beaver's (white) castor
6 Bone of sharp legs
7 Corn bug, itself
8 Dry hand
9 Hair of wind spirit
10 Nia″-gwa-hē's bones.

A translation of the opening ceremony of this society is here given:

YOT-DON-DAK-KOH

Opening ceremony of the Pygmy Society

We now commence to thank our Creator.
Now we are thankful that we who have assembled here are well.
We are thankful to the Creator for the world and all that is upon it for our benefit.
We thank the sun and the moon.
We thank the Creator that so far tonight we are all well.
Now I announce that *A. B.* is to be treated.
Now this one *C. D.* will throw tobacco in the fire.
Now these will lead the singing, *E.* and *F.*
So I have said.

The "tobacco thrower" advances to the fire and seating himself takes a basket of Indian tobacco and speaks as follows:

Now the smoke rises!
Receive you this incense!
You who run in the darkness.
You know that this one has thought of you
And throws this tobacco for you.
Now you are able to cause sickness.
Now when first you knew that men beings were on earth you said "They are our grandchildren."
You promised to be one of the forces for men being's help
For thereby you would receive offerings of tobacco.

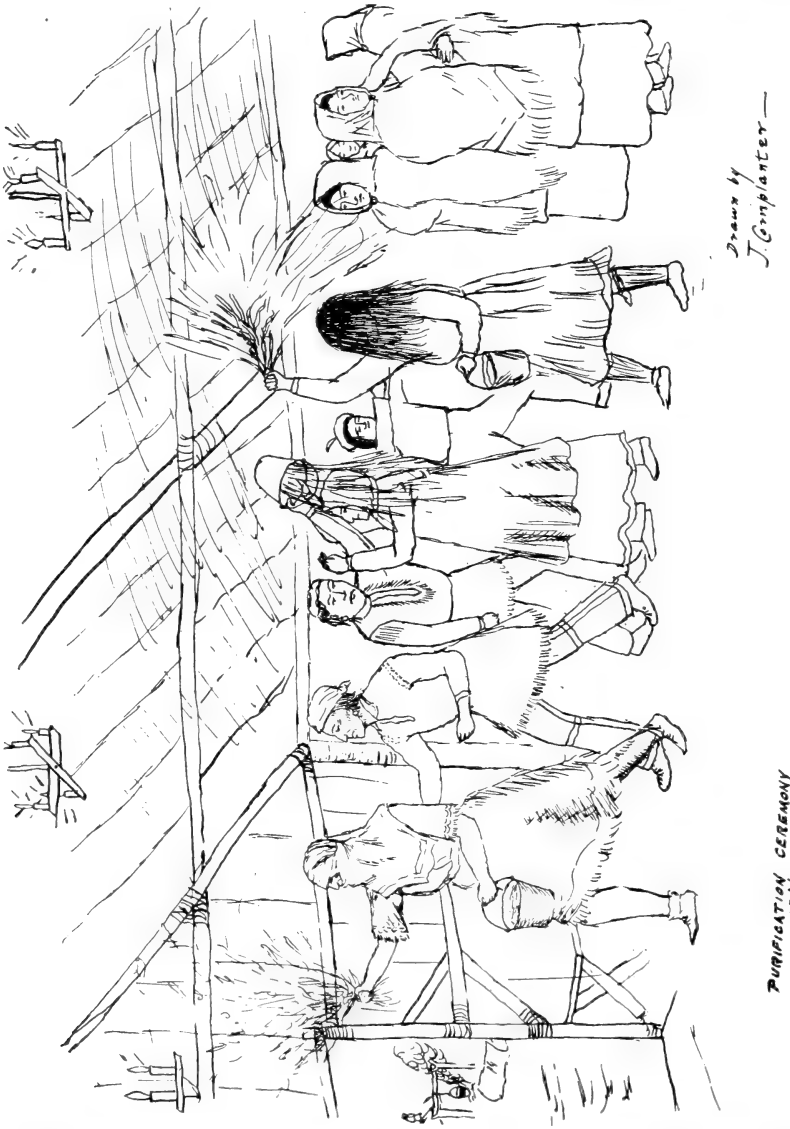
So now you get tobacco, you, the pygmies. (Sprinkles tobacco on the fire.)
Now is the time when you have come,
You and the members have assembled here tonight.
Now again you receive tobacco, you, the pygmies. (Throws tobacco.)
You are the wanderers of the mountain,
You have promised to hear us whenever the drum sounds,
Even as far away as a seven days' journey.
Now all of you receive tobacco. (Throws tobacco.)
You well know the members of this society,
So let this cease. (The maliferous influence causing sickness).
You are the cause of a person, a member, becoming ill.
Henceforth give good fortune for she (or he) has fulfilled her duty and given you tobacco.
You love tobacco and we remember it,
So also you should remember us.
Now the drum receives tobacco,
And the rattle also.
It is our belief that we have said all
So now we hope that you will help us.
Now these are the words spoken before you all,
You who are gathered here tonight.
So now it is done.

Dâ-wän'-do^n, or Otter Society

1 The Society of Otters, *Dâwändo^n,* is a band of people organized to propitiate the otters and other water animals who are supposed to exercise an influence over the health, fortunes and destinies of men. The otter, who is the chief of the small water animals, including the fish, is a powerful medicine animal and besides having his own special society is a member of the *Iē''-dos* and the *Hono'tcino''gä.*

2 The Otters may appear at any public thanksgiving, as the Green Corn dance and the Midwinter thanksgiving. After a tobacco throwing ceremony, *hayänt'wŭtgŭs,* the three women officers of the *Dâwändon* each dip a bucket of the medicine water from the spring or stream, dipping down with the current, and carry it to the council house where they sprinkle every one whom they meet by dipping long wisps of corn husk in the water and shaking them at the people. If the women succeed in entering the council house and sprinkling every one without hindrance they will go for more water and continue until stopped. The only way in which they may be forced to discontinue their sprinkling is for some one, just before she sprinkles him, to snatch the pail and throw the entire contents over her head. The Otter woman will then say, "*Hât'ĕ-gäii, niä-wĕh!*" meaning, "Enough, I thank you." She will then retire.

3 The Otters are specially active during the midwinter ceremony and when the water is thrown over their heads it very often freezes, but this is only something to be enjoyed. The women when pos-



Purification ceremony of the Society of Otters, a Seneca women's winter ceremony

sessed with the spirit of the otter are said to be unaware of their actions and sometimes when they are particularly zealous the whistle of the otter is heard. This greatly frightens the people

who regard it as a manifestation of the presence of the "great medicine otter." The women afterward deny having imitated the otter's call saying that they were possessed with the otter and have no knowledge of what they did.

4 The Otter Society has no songs and no dances. They are simply organized to give thanks to the water animals and retain their favor. When some one is ungrateful to the water animals, as a wasteful fisherman or a hunter who kills muskrats or beaver without asking permission or offering tobacco to their spirits, they become strangely sick, so it is believed. The otters then go to a spring and hold a ceremony after which they enter the sick man's lodge and sprinkle him with the spring water hoping thereby to cure him.

Opening or tobacco throwing ceremony of the False Face Company

Now receive you this tobacco, you, *Shagodowegowa,* the great false face,

Now it is that you have come to where your grandchildren are gathered.

Now you are taking the place of the great false faces who are wandering in the rocky valleys and mountains.

Now you are the ones who think much of this sacred tobacco.

Now we wish to make a request of you. So we always offer this sacred tobacco, (literally, real tobacco), when we ask anything of you.

We pray that you help us with your power.

You can go over all the earth.

In the center of the earth is a great pine tree and that is the place of your resting. It is there that you rub your rattle when you come to rest.

Now then this tree receives this tobacco.

We ask that you watch over us and exercise your power to protect us from anything harmful.

We hold in mind that you have ever done your duty in past times and we ask that you continue (vigilant) henceforth.

We use this tobacco when we ask favors of you for you are very fond of this tobacco.

Now your cane gets tobacco. The great pine tree to its top is your cane.

Now you, the husk faces, you get tobacco also.

You have been associated with the false faces in times past. Now you receive tobacco for you have done your duty.

So it is finished.

VIII

THE PROTECTION OF NATURAL MONUMENTS

In the hope of stimulating among intellectual centers a proper regard for the unique or exceptional work of nature, the accompanying circular was generally distributed early in the year to local scientific and patriotic societies and to private individuals. Its purport was directed less to the regard of the greater scenic effects of the State than to the minor phenomena which often constitute a special local attraction and have a genuine scientific or historic merit which ought to commend them to protection. Such lesser objects are easily overridden and effaced with the advance of settlement and industrial development. A proper sentiment, well aroused, will prevent their destruction and leave to posterity something better than regrets for their disappearance. It has seemed proper for this department to take the initiative in this matter even though it may not be practicable to press the movement by substantial assistance.

THE PROTECTION OF NATURAL MONUMENTS

It might seem unpatriotic to say that they do some things in the old country better than we do. They certainly do good things which in our busy community life we have not yet got around to. One of these is the local protection of places and objects of particular *natural* interest. We have done well in the conservation of historic spots, and the State of New York is most creditably dotted over with monuments commemorating great events, and with small reservations where large deeds have been done. Few communities are without some memorial permanently marking the telling facts of their history, and fortunate indeed is the town that has an organized spirit for such efforts; twice blest in a man or a few men willing upon their own initiative to make such a spirit bear fruit.

The conservation of especially interesting *natural objects* comes somewhat late in the development of the sentiment of a community, with the increase in the appreciation of nature's works. There are lovers of birds who see with profound regret the disappearance of certain of their friends once common in the region, but gradually driven away by the encroachments of commerce upon their nesting places. There are lovers of plants who know the few remaining spots where rare flowers bloom or rare ferns may be found. What comparison does a loyal citizen make between a noble tree which has seen the centuries roll by, which has stood sentinel over the community since the cradle days of the settlement, and the light or telephone company which lops off one of its branches to let a wire go through or thrusts an ugly pole into its boughs? A

wooden telephone pole with its crosstrees is today in our cities and villages the cross on which every sentiment of good and decent taste is crucified. There are persons in most every community who can be better spared than some of its venerable trees. It is not only the age of a tree that entitles it to guardianship; there are some which have especial associations with distinguished personages of the past, others may be the last survivors of a race which once abounded but whose companions have disappeared under the woodsman's axe. A great glacial rock boulder projecting alone from some meadow or hillside, tells a romantic age long story which should not be menaced by the workman's sledge. There are bits of swamp still profuse in rare orchids, and clumps of woodland where the rare birds still nest but which will soon be robbed of their possessions if measures are not taken for their protection.

Let us cite, for an example, the *Bergen swamp* in Genesee county, famous among botanists as a spot where still linger the Painted trillium, yellow Clintonia, the twin flower or Linnaea and rare orchids such as the White cypripedium and numerous northern plants which, scarce or wanting in all other localities of western New York, thrive in the cool recesses of this spot or on its open bogs among the Cranberries, Huntsman's cup and Andromedas. Here northern birds, the Hermit thrush, Winter wren and Canadian warbler find their breeding place. Here are the coverts of the Grouse, Woodcock and other game birds and a center of their dispersal. The indwellers in this place are threatened by the incursions of commerce, of ruthless sport, of agricultural aggression, but this swamp if protected would not alone continue to play its part in regulating the flow of the river which runs out of it into the Genesee, but afford a reserve for its rare flowers and birds and form a charming bit of the North Woods — a boreal island — in western New York, with the towns of Rochester, Batavia, Buffalo, Tonawanda, Lockport, Medina and Albion within easy reach of its attractions.

In Germany, substantial progress has been made in protecting such objects of natural interest. The methods employed and the results achieved are interesting. An old fir tree gnarled with years in the forest of Lueneburg is set apart and protected for its very age and fascinating ugliness. A little patch of dwarf birch, a rare survivor of the postglacial flora, is preserved and protected in the vicinity of Hamburg. A considerable area of forest near Muenster is protected because of its profusion in certain rare species of lichens. In Schleswig a great glacial boulder resting on a low knoll has been set aside, the ground immediately about it acquired and a road laid out to it. In Brandenburg a little lake with its swamp, the Plage, has been reserved on account of its botanic interest and in Marienwerder a bit of lake and woods where rare water birds nest. A local society in Gotha has acquired a small pond and swamp and has transferred to it rare plants threatened with extinction and has also introduced new plants foreign to the region, such as our common Sarracenia or Pitcher-plant.

Such results as these have been attained very largely through the activity of local societies and are the outcome of local pride and intelligent appreciation. Prussia, however, has an official, duly appointed by the Cultus Minister as State Commissioner for the Preservation of Natural Memorials, and through his activity, aided by the official forestry organization, much is possible which would be more difficult here without such aid. The State of New York may some time in the not too distant future have such an agency to bring about these desirable ends, but even without it much can be done now by local societies and zealous individual effort. The State has seen its duty to acquire and preserve a beautiful but expensive spot in Watkins glen; it ought to see its way to conserve that still more marvelous work of nature, the Ausable chasm, but the preservation of the lesser objects should fall to the proper pride of the localities where they are situated.

No part of this large State is without such objects appealing to the thoughtful citizen for protection — the rock bridge over the Perch river near Watertown; the unique burless chestnut near Freehold; the immense Arbor vitae on the outlet of Lake Colden; the extinct volcano near Schuylerville, once a redoubt during the Champlain wars of the Revolution; the Diamond Rock at Lansingburg with its beautiful Indian legend — each community knows best its own natural monuments.

We desire to bring these considerations to the notice of local scientific and civic organizations. The members of such societies are always open to appeals to civic pride; many of them are lovers and appreciative students of nature who must see with increasing regret the gradual disappearance of, or injury to, such objects of natural interest.

It is respectfully requested that this circular be laid before your society. It is hoped that its members may see the propriety of appointing a standing committee to inquire into the possibility of local protection. It is not too soon. The opportunity once gone, it is forever too late. The damage once done can never be repaired. Local loyalty based upon intelligent appreciation is a first essential to success; the next, sympathetic interest on the part of the legal owner of such objects. With the first assured, the second is not difficult to secure. It will not cost much to put a protecting fence about a rare or venerable tree or authoritative notices of warning about and within reservations of field and woodland, glen or swamp, worthy of conservation for their natural interest. It is worth while doing this; lovers of nature and the out of doors, students of science everywhere, intelligent members of every community in this and following generations will rejoice that you have done these things.

The Science Division of the Education Department desires to be helpful in such undertakings as are here outlined. It seeks to encourage them and will do so with all the means at its disposal and all the influence it possesses. It asks to be kept informed in regard to efforts of this kind and the specific objects toward which they

are directed. It wishes to be in a position to compile a list of the natural monuments which are or should be protected and to issue information in regard to efforts made toward their protection for the information and encouragement of the general public.

JOHN M. CLARKE
June 1908 *Director*

IX

PUBLICATIONS

A list of the scientific publications issued during the year 1907–8 with those now in press and treatises ready for printing is attached hereto. The publications issued are 21 in number on a variety of topics covering the whole range of our scientific activities. They embrace 2378 pages of text, 288 plates and 20 maps.

The labor of preparing this matter, verifying, editing and correcting is onerous and exacting. Taken altogether it excellently indicates the activity and diligence of the staff of this division.

Annual report

1 Fourth Report of the Director, State Geologist and Paleontologist for the fiscal year ending September 30, 1907. 212p. 56pl.

Contents:

Memoirs

2 No. 9 pt 1 Early Devonic of New York and Eastern North America. By John M. Clarke. 366p. 70pl. 5 maps.

Contents:

3 No. 11 Graptolites of New York. Part 2, Graptolites of the Higher Beds. By R. Ruedemann. 584p. 2 tab. 31pl.

Contents:

Bulletins

Geology

4 No. 119 Geology of the Adirondack Magnetic Iron Ores. By D. H. Newland. With a report on the Mineville-Port Henry Mine Group. By J. F. Kemp. 184p. 14pl. 8 maps.

Contents:

5 No. 120 Mining and Quarry Industry of New York. 4th report. By D. H. Newland. 82p.

Contents:

6 No. 123 Iron Ores of the Clinton Formation in New York State. By D. H. Newland and C. A. Hartnagel. 76p. 14pl. 3 maps.

Contents:

Paleontology

7 No. 118 Geologic Map and Descriptions of the Portage and Nunda Quadrangles including a map of Letchworth Park. By John M. Clarke & D. D. Luther. 52p. 16pl. 4 maps.

Contents:

Entomology

8 No. 124 Report of the State Entomologist for the fiscal year ending September 30, 1907. 542p. 44pl.

Contents:

Botany

9 No. 122 Report of the State Botanist for the fiscal year ending September 30, 1907. 178p. 5pl.

Contents:

Archeology

10 No. 117 An Erie Indian Village and Burial Site. By A. C. Parker. 102p. 38pl.

Contents:

Geological maps

11 Nunda-Portage Quadrangles

IN PRESS

Memoirs

12 Early Devonic of New York and Eastern North America. Part 2

13 Birds of New York

Bulletins

Geology

14 Later Glacial Waters in Central New York

15 Geneva-Ovid Quadrangles

16 Remsen Quadrangle

Zoology

17 Osteology of Birds

Entomology

18 Report of the State Entomologist for the fiscal year ending September 30, 1908

Archeology

19 Myths and Legends of the New York State Iroquois

X

STAFF OF THE SCIENCE DIVISION AND STATE MUSEUM

The members of the staff, permanent and temporary, of this division as at present constituted are:

ADMINISTRATION

John M. Clarke, *Director*
Jacob Van Deloo, *Director's clerk*

GEOLOGY AND PALEONTOLOGY

John M. Clarke, *State Geologist and Paleontologist*
David H. Newland, *Assistant State Geologist*
Rudolf Ruedemann Ph.D., *Assistant State Paleontologist*
C. A. Hartnagel B.S. M.A., *Assistant in Geology*
Henry Leighton, *Assistant in Economic Geology*
D. Dana Luther, *Field Geologist*

Herbert P. Whitlock C.E., *Mineralogist*
George S. Barkentin, *Draftsman*
Joseph Morje, *First clerk*
H. C. Wardell, *Preparator*
Paul E. Reynolds, *Stenographer*
C. J. Robinson, *Clerk*
Martin Sheehy, *Machinist*

Temporary assistants

Precambric geology

Prof. H. P. Cushing, Adelbert College
Prof. J. F. Kemp, Columbia University
Dr C. P. Berkey, Columbia University
Prof. C. H. Smyth jr, Princeton University
Prof. C. E. Gordon, Massachusetts Agricultural College

Stratigraphic geology

G. H. Hudson, Plattsburg State Normal School
Prof. W. J. Miller, Hamilton College

Geographic geology

Prof. Herman L. Fairchild, Rochester University

Paleontology

David White, United States Geological Survey
Dr T. Wayland Vaughan, United States Geological Survey
Edwin Kirk, Columbia University

BOTANY

Charles H. Peck M.A., *State Botanist*
Stewart H. Burnham, *Assistant*, Glens Falls

ENTOMOLOGY

Ephraim P. Felt, B.S. D.Sc., *State Entomologist*
D. B. Young, *Assistant State Entomologist*
Fanny T. Hartman, *Assistant*
Anna M. Tolhurst, *Stenographer*
J. Shafer Bartlett, *Page*

ZOOLOGY

Frank H. Ward, *Zoologist*
Alfred J. Klein, *Taxidermist*

Temporary assistants

E. Howard Eaton, Canandaigua
Dr E. J. Letson, Buffalo

ARCHEOLOGY

Arthur C. Parker, *Archeologist*

XI

ACCESSIONS

ECONOMIC GEOLOGY

Donation

Dannemora Granite Co. Dannemora. Granite, polished (Keystone), Dannemora	1
Juvet, L. V. Glens Falls. Marble, polished, Buck Mountain, Lake George	1
Ross, James. Linlithgo. Manganese ores from McCormick, S. C.	17
Total	19

PALEONTOLOGY

Donation

Clarke, John M. Series of Chemung fossils from Warren, Pa. Collected by F. A. Randall	31
Cambric fossils from Province of Estland, Russia. Collected by A. Mickwitz	25
Gillard, John. Stafford. Fossils from Stafford limestone	350
Fossil fish from Onondaga limestone	5
His excellency Governor and Mrs Allardyce, Falklands Islands. Eodevonic fossils from Falkland Islands	20
Hamling, J. E. Barnstaple, Eng. Devonic fossils:	
Spirifer disjunctus	4
S. laevicostus	1
S. hystericus	1
Phacops latifrons	1
Petraia	1
Cucullaea hardingii	1
Cyathophyllum caespitum	2
Pleurodictyum problematicum	1
Hudson, *Prof.* **G. H.** Fossils from the Chazy limestone, Valcour Island	17
Katzer, *Dr* **Friedrich.** Types of Devonic Fossils, "Grundzüge der Geologie des unteren Amazonasgebietes" 1903, pl. XII, fig. 3 A, 3 B	2

Also 5 fossils and 2 plaster casts from Middle Devonic, Ererè, Brazil 7

Mattimore, H. S. Trilobites from near Schoharie 2

Barnard, A. W. Ridgewood, N. J. Coral (Favosites), Indian Ladder, Albany co 1

Kelley, F. W. Albany. Coral (Favosites), Howes Cave, Schoharie co 1

von Koenen, *Prof. Dr* **A.** Göttingen, Germany. Upper Devonic fossils from the Enkeberg, Westphalia:

Aganides lentiformis *Sandberger* 2
A. sulcatus *Münster* 1
Cheiloceras enkebergense *Wedekind* 1
C. verneuilli *Münster* 1
Clymenia angustiseptata *Münster* 1
C. dunkeri *Münster* 1
C. enkebergensis *Wedekind* 2
C. frechi *Wedekind* 2
C. hexagona *Wedekind* 1
C. involuta *Wedekind* 2
C. lotzei *Wedekind* 1
C. pompeckji *Wedekind* 1
C. roemeri *Wedekind* 1
C. sandbergeri *Wedekind* 1
C. striata *Münster* 1
C. subflexuosa *Münster* 1
Dimeroceras bergense *Wedekind* 1
D. gümbeli *Wedekind* 1
D. padbergense *Wedekind* 1
Praeglyphioceras pseudosphaericum *Frech* 2
Prolobites delphinus *Sandberger* 2
P. delphinus *var.* atava *Frech* 1
P. delphinus *var.* ellipticus *Wedekind* 1
Sporadoceras angustisellatum *Wedekind* 1
Sporadoceras clarkei *Wedekind* 1
S. contiguum *Münster* 2
S. discoidalis *Wedekind* 1
S. münsteri *von Buch* 1
S. rotundum *Wedekind* 1
Tornoceras planidorsatum *Münster* 2
T. sandbergeri *var.* dillensis *Drev* 1
T. rotundodorsatum *Wedekind* 1

Mesozoic fossils:

Coelodus mantelli *Ag* 1
Mesodon 1
Lexicodon zugleri *Meyer* 1
Stephanoceras trijungeus *Münster* 1
Ancycloceras crassum *von Koenen* 3

Exchange

Emerson, *Prof.* **B. K.** Amherst, Mass. Fossils from Turkish Empire. 62

Purchase

Arey, A. L. Types used in New York State Museum memoir 5 Guelph Formation and Fauna of New York State 1903 93
Guelph fossils from vicinity of Rochester 150
Bishop, I. P. Eurypterids from Buffalo quarries 2
Kazenstein, *Mrs* **Fannie.** Fossil plant from near Hancock, Delaware co. 1
Krantz, *Dr* **F.** Bonn, Germany. European trilobites 6
Ward's Natural Science Establishment, Rochester. Development series of Sao hirsuta Bar 20

Collection

Braun, Frederick. Fossils from Onondaga limestone vicinity of Leroy and Caledonia 144
Eurypterids from Herkimer co 800
Clarke, J. M. Fossils from Gaspé county, Canada .... bbls 51
Hudson, *Prof.* **G. H.** Chazy fossils from Valcour Island 4
Types used in paper by G. H. Hudson "On some Pelmatozoa from the Chazy limestone of New York" New York State Museum bulletin 107. 1907 19
Luther, D. D. Starfishes and crinoids from near Naples 74
Loose slabs (sponges) from Italy Hollow gully, Yates co 7
Fish, Paropsonema etc., from near Naples 15
Hamilton fossils from near Darien 5
Eurypterids from Morganville 4
Luther, D. D. *&* **Braun, Frederick.** Starfishes and crinoids from Italy Hollow gully near Naples 75
Ruedemann, R. Fossils from Trenton limestone near Crown Point. 5
Large Lowville slabs with Tetradium from Chaumont 6
Fossils from Lowville, Black River and Pamelia limestone collected during mapping of Clayton topographic sheet 100
Van Deloo, Jacob. Chazy fossils from Keeseville 50
Fossils from Potsdam sandstone, Ausable Chasm 3
Wardell, H. C. Eurypterids from Shawangunk grit, Otisville 24
Oriskany and Schoharie grit fossils from Erie railroad cut near Highland Mills 35
Oriskany fossils from Glenerie 400
Eurypterids from roadway near Ray Ball's house 3 miles north of Cedarville, Herkimer co 35
Hamilton fossils from near Mt Marion station, Ulster co 15

Total 26744

MINERALOGY

Donation

Cameron, T. Pyrite, Hermon 38
Stafford, M. A. Pittsfield, Mass. Rutile in quartz. Mt Holyoke, Mass. 5

Bender, R. W. Hudson. Gypsum crystals, Hudson................ 35
Hearn, J. A. Burwell, Ga. Halloysite, Burwell, Ga................ 4
Hindshaw, H. H. New York
Magnesite, Marquenta, Venezuela.................................... 1
Orthoclase, Owl's Head.. 2
Fluorite, Chalcopyrite and quartz, Benson Mines.................... 1
Hartnagel, C. A. Albany. Corundum 1
Chadwick, G. H. Canton
Calcite, Schenectady 5
Calcite, Catskill 6

Purchase

Nims, A. F. Philadelphia
Apatite (large), Burgess, Can....................................... 3
Apatite (crystals), Burgess, Can.................................... 80
Muscovite, Lena River, Can.. 1
Titanite, Grattan, Can.. 479
Titanite and pyroxene, Grattan, Can................................. 3
Pyroxene, Grattan, Can.. 531
Orthoclase and pyroxene, Grattan, Can............................... 27
Orthoclase and titanite, Grattan, Can............................... 1
Pyroxene and wernerite, Grattan, Can................................ 2
Quartz (amethyst), Nova Scotia, Can................................. 5
Analcite and natrolite, Nova Scotia, Can............................ 1
Apophyllite, Nova Scotia, Can....................................... 17
Quartz (flint nodule), Dover, Eng................................... 1
Barite and siderite, Weardale, Eng.................................. 1
Tetrahedrite, Clausthal, Ger.. 1
Garnet, Fort Wrangel, Alas.. 7
Quartz (geodes), Iowa... 10
Cyanite, Tyrringham, Mass... 5
Diaspore, Chester, Mass... 2
Rutile, Magnet Cove, Ark.. 3
Chromite, Lancaster co., Pa... 9
Wavellite, York co., Pa... 2
Chromite in serpentine, Hoboken, N. J............................... 1
Mesolite (harringtonite), Weehawken, N. J........................... 1
Apophyllite and calcite, Bergen Hill, N. J.......................... 2
Datolite, Bergen Hill, N. J... 2
Vanuxemite, Franklin, N. J.. 1
Crocidolite, Cumberland, R. I....................................... 1
Margarite, Trumbull, Conn... 1
Lazulite, Lincoln co., N. C... 1
Brochantite, Utah 1
Wulfenite, Utah 1
Borax, Clear Lake, Col.. 1
Orthoclase, Hammond 15
Orthoclase and pyroxene, Hammond.................................... 7
Orthoclase and amphibole, Hammond................................... 2

Orthoclase and titanite, Hammond	2
Orthoclase and wernerite, St Lawrence co	1
Microcline (large), Pitcairn	5
Microcline, Pitcairn	156
Microcline and pyroxene, Pitcairn	18
Microcline and amphibole, Pitcairn	8
Microcline and muscovite, Pitcairn	2
Microcline and titanite, Pitcairn	1
Oligoclase, Fine	311
Oligoclase (moonstone), Fine	39
Pyroxene and wernerite, Yellow Lake	1
Pyroxene (diopside) De Kalb	57
Pyroxene and microcline, Pitcairn	7
Pyroxene and wernerite, St Lawrence co	1
Pyroxene (malacolite), Richville	2
Pyroxene, Gouverneur	6
Pyroxene, Pitcairn	86
Pyroxene (crystals), Pitcairn	325
Pyroxene, St Lawrence co	201
Amphibole, Edwards	8
Amphibole (tremolite), Edwards	1
Amphibole (hexagonite), Edwards	53
Amphibole (tremolite), Gouverneur	249
Chalcopyrite and pyrite in quartz, Fowler	2
Sphalerite and galena, Rossie	1
Sphalerite and fluorite, Macomb	1
Pyrite and sphalerite, Hermon	9
Pyrite, Hermon	box, 1
Pyrite (in matrix), Hermon	26
Pyrite (crystals), Hermon	24
Pyrite and amphibole, Hermon	1
Fluorite, Macomb	453
Quartz, Natural Bridge	63
Quartz, Fowler	12
Quartz (pseudomorphs), St Lawrence co	85
Quartz and hematite, Fowler	4
Quartz, dolomite and prochlorite, Antwerp	1
Quartz and hematite, Antwerp	2
Limonite on hematite, St Lawrence co	1
Goethite on dolomite, Antwerp	1
Calcite, Rossie	1
Calcite (cleavage), Rossie	7
Calcite, St Lawrence co	2
Calcite, Natural Bridge	173
Calcite and fluorite, St Lawrence co	15
Calcite (cleavages), Diana	42
Pyrolusite and quartz, St Lawrence co	1
Spinel in serpentine and limestone, Sommerville	5
Amphibole and magnetite, Edwards	3
Amphibole, St Lawrence co	26

Amphibole (pargasite), Rossie	3
Wernerite and pyroxene (large), Pierrepont	1
Wernerite, Pierrepont	30
Wernerite and pyroxene, Pierrepont	4
Wernerite, Rossie	1
Wernerite, Yellow Lake	4
Wollastonite, Natural Bridge	2
Tourmalin and pyroxene, Pierrepont	1
Tourmalin in quartz, Pierrepont	1
Tourmalin, Pierrepont	245
Tourmalin, Gouverneur	339
Tourmalin, Edwards	23
Phlogopite, Edwards	15
Talc, Edwards	19
Danburite (large), Russell	7
Danburite, Russell	218
Biotite, Natural Bridge	1
Talc (pseudomorph after amphibole), St Lawrence co	1
Serpentine (pseudomorph after pyroxene), Gouverneur	11
Serpentine, Edwards	19
Titanite, Natural Bridge	289
Apatite, St Lawrence co	1
Apatite, Gouverneur	1
Barite, hematite and quartz, Fowler	1
Barite, siderite and hematite, Sommerville	1
Barite, Rossie	8
Barite, Richville	7
Chabazite, Loc. ?	2
Muscovite "	1
Garnet in epidote "	1
Garnet in quartz "	1
Epidote in quartz "	2
Vesuvianite "	1
Aragonite "	1
Psilomelane "	1
Garnet in mica schist "	20
Barite "	2
Opal (hyalite) "	1

Mitchell, C. De Kalb

Diopside (crystals) De Kalb	6
Tourmalin, De Kalb	4

Hodge, *Capt.* **R. S.** Antwerp

Calcite, Antwerp	10
Calcite, Sommerville	8
Chalcopyrite, Sommerville	11
Pyrite, Sommerville	10

Vrooman, Howard, Albany. Quartz (crystals), Castleton 34

Collection

Assistant State Geologist. Diopside, De Kalb	19
Mineralogist. Quartz, Whitehall	5
Calcite, West Camp	17
Calcite, South Bethlehem	26
Wardell, H. C.	
Sulphur and gypsum on limestone, Lime Rock	1
Calcite on limestone, Hudson	1
Total	5266

BOTANY

Plants added to the herbarium

New to the herbarium

Aecidium importatum *Henn.*
Amanita glabriceps *Pk.*
A. porphyria *Fr.*
Aster vittatus *Bu.*
Botrytis plebeja *Fres.*
Brassica japonica *Sieb.*
Calicium alboatrum *Floerk.*
Celtis crassifolia *Lam.*
Cephalozia lunulaefolia *Dum.*
Cercospora rudbeckiae *Pk.*
Clitocybe comitialis *Pers.*
Collybia hirticeps *Pk.*
Cololejeunea biddlecomiae (*Aust.*)
Commelina communis *L.*
Crataegus admiranda *S.*
C. barbara *S.*
C. bella *S.*
C. boothiana *S.*
C. brachyloba *S.*
C. celsa *S.*
C. cerasina *S.*
C. clintoniana *S.*
C. conferta *S.*
C. congestiflora *S.*
C. cruda *S.*
C. dayana *S.*
C. finitima *S.*
C. foliata *S.*
C. gloriosa *S.*
C. gracilis *S.*
C. implicata *S.*
C. limosa *S.*
C. luminosa *S.*
C. notabilis *S.*
C. oblita *S.*
C. placiva *S.*
C. promissa *S.*
C. pulchra *S.*
C. radiata *S.*
C. robusta *S.*
C. slavini *S.*
C. strigosa *S.*
C. tortuosa *S.*
C. xanthophylla *S.*
Dacryomyces corticioides *E. & E.*
Diaporthe atropuncta *Pk.*
Diplodina robiniae *Pk.*
Fusarium aurantiacum *Cd.*
Geoglossum alveolatum *Durand*
Gloeosporium medicaginis *E. & K.*
Gonatobotrys lateritia *Pk.*
Hygrophorus sphaerosporus *Pk.*
Hymenula musae *Pat.*
Hypholoma fragile *Pk.*
Lactarius peckii *Burl.*
Lecanora fuscata (*Schrad.*) *Th. Fr.*
Leptosphaeria inquinans *Pk.*
Leucolejeunea clypeata (*Schw.*)
Lophocolea macouni *Aust.*
L. minor *Nees*
Massariovalsa sudans (*B. & C.*) *Sacc.*
Melaconis modonia *Tul.*
Mnium orthorrhynchium *B. & S.*
Myxosporium castaneum *Pk.*
Nardia crenuliformis (*Aust.*) *Lindb.*
Nectria sambuci *E. & E.*
Neottiella polytrichi (*Schum.*) *Mass.*
Pellia endiviaefolia (*Dicks.*) *Dum.*
Phoma corni *Fckl.*

P. lagenariae (*Thuem.*) *Sacc.*
Phyllosticta orbicula *E. & E.*
Polyporus arcularis (*Batsch*) *Fr.*
P. delectans *Pk.*
P. trabeus *Rostk.*
Puccinia agrostidis *Plow.*
P. albiperidia *Arth.*
P. campanulae *Carm.*
P. phlei-pratensis *E. & H.*
Pucciniastrum potentillae *Kom.*
Rhinotrichum curtisii *Berk.*
Solanum rostratum *Dunal*
Sorosporium saponariae *Rud.*
Sphenolobus hellerianus (*Nees*)
Sporodesmium pluriseptatum (*K. & H.*)
Tricholoma subcinereum *Pk.*
Trichothecium candidum *Wallr.*
Uromyces caricinus *E. & E.*
U. scirpi (*Cast.*) *Burr.*
Volutella cucurbitina *Pk.*

ENTOMOLOGY

Donation

Hymenoptera

Hough, R. B. Lowville. Amphibolips prunus Walsh, oak plum gall, Sept., from Michigan

Harrington, Daniel. Cambridge. Trichiocampus viminalis Fallen, poplar sawfly larvae, Aug. 21

Woodford, L. L. Pompey. Kaliosysphinga ulmi Sund., leaf miner on elm, June 16

Von Schrenk, Hermann. St Louis, Mo. Urocerus edwardsii Brulle, Jan. 7

Coleoptera

State Agricultural Department. Eccoptogaster rugulosus Ratz., fruit tree bark beetle on pear, following work of Tmetocera ocellana? Sept. 15, from Rochester

Peck, C. H. Albany. Cryptorhynchus lapathi Linn., mottled willow borer, larvae on balm of gilead, Aug. 10, from Corning

Belden, D. B. Fredonia. Tyloderma fragariae Riley, strawberry crown borer, June 11

Newbury, J. G. Coxsackie. Pissodes strobi Peck, white pine weevil, larvae on pine, July 6

Barber, G. H. Westfield. Chelymorpha argus Licht., argus tortoise beetle, larvae on grape, June 25

Milligan, A. E. Schuylerville. Galerucella luteola Müll., elm leaf beetle, larvae and pupae, July 9

Von Steenburgh, J. C. Ballston. Plagionòtus speciosus Say, sugar maple borer, adult on maple, June 26

Shanks, *Dr* **S. G.** Albany. Photinus? pyralis Linn., firefly, serial, longitudinal and transverse sections, adult

Diptera

Brakeley, J. T. Hornerstown, N. J. Culex perturbans Walk., all stages, June and July

Clarke, *Miss* **Cora H.** Magnolia, Mass. A number of Cecidomyiid galls

Siphonaptera

Kathan, Dudley R. Schenectady. Pulex irritans Linn., common human flea, adult; Ctenocephalus canis Curt., cat and dog flea, adult, July 24

Lepidoptera

Dutche, M. J. Oakwood Heights, S. I. Basilona imperialis Dru., imperial moth, larva, Sept. 3

Kelly, *Dr* A. B. Albany. Larva of the preceding on maple, Aug. 12

Thompson, J. A. Rochester. Hyphantria textor Harr., fall web worm, larvae on apple, July 7

Otterson, H. N. Bolton, Mass. Halisidota caryae Harr., hickory tussock moth, larvae, July 8

Thornton, Irving T. Orchard Park. Larvae of the preceding, July 6

Graves, George S. Newport. Tolype velleda Stoll., lappet moth, larva, July 22

Mair, A. Oakdale, L. I. Alsophila pometaria Harr., fall canker worm, young, June 5

Reel, C. Gordon. Kingston. Ennomos subsignarius Hübn., snow-white linden moth, adult, July 23, through Forest, Fish and Game Com'n

Ensign, W. O. Livingston Manor. Pupae of the preceding on oak, July 3

Covert, H. W. Waterford. Ania limbata Haw., filament bearer or horned spanworm, larva, June 6

Englehardt, G. P. Brooklyn. Memythrus tricinctus Harr., M. polistiformis Harr., M. simulans Grote, M. asilipennis Boisd., M. dolii Neum., Aegeria apiformis Clerck, Sesia bassiformis Walk., S. albicornis Hy. Edw., S. corni Hy. Edw., S. pyri Harr., S. scitula Harr., S. rubristigma Kellicott, and S. pyralidiformis Walk. Apr. 30

Niles, T. F. State Department of Agriculture. Thyridopteryx ephemeraeformis Haw., bag worm, larvae on red cedar, July 7, from Germantown, N. Y.

Holmes, F. B. Albany. Sitotroga crealella Oliv., adult in popcorn, Aug. 14

Thompson, J. A. Rochester. Tischeria malifoliella Clem., apple leaf miner, larvae on apple, July 7

Odonata

Goldring, Winifred. Slingerland. Hetaerina americana Fabr., adult, Aug. 26

Hemiptera

American Nursery Co. New York city. Phylloxera caryaecaulis Fitch, hickory gall aphid, adults and young on hickory, June 8

Munson-Whitaker Co. New York city. Gall of preceding on hickory, Sept. 1

Woodford, L. L. Pompey. Colopha ulmicola Fitch, cockscomb elm gall, June 18

Thornton, Irving T. Orchard Park. Young of preceding on elm, July 6

Freeman, *Mrs* **George H.** Loudonville. Pemphigus acerifolii Riley, on maple, Sept. 19

Downing, George S. Albany. Pemphigus tessellata Fitch, nymphs on alder, Aug. 24

Herliky, John. Brooklyn. Chermes abietis Linn., spruce gall aphid, young on Norway spruce, June 22

Terry, Seth Sprague. Elizabethtown. Galls of preceding, July 30

Laney, C. C. Rochester. Galls of preceding on spruce, Aug. 10

Nill, John. Star Lake. Dead adults of preceding on spruce, Aug. 31

Kenney, W. E. Brooklyn. Aspidiotus perniciosus Comst., San José scale, adult on hornbeam, Oct. 13

Aspinwall, J. Newburgh. Eulecanium tulipiferae Cook, tulip tree scale, young on tulip tree, Apr. 6

Brignall, E. S. Schenectady. Pulvinaria innumerabilis Rathv., cottony maple scale, adults on elm, June 2

Niles, *Mrs* **Stephen.** Coeymans. Same as preceding, on maple, June 12

Concklin, E. R. Pomona. Adults of preceding on maple, June 24

Downer, Frank H. New Rochelle. Phenacoccus acericola King, false maple scale, young on maple, Oct. 12

Beakley, G. F. Johnstown. Same as preceding, May 29

Huested, S. B. Blauvelt. Adult of preceding on maple, July 29

Brignall, E. S. Schenectady. Gossyparia spuria Mod., elm bark louse, adults on elm, June 2

Kenney, W. E. Brooklyn. Same as preceding, Aug. 3

Mains, *Mrs* **W. C.** Mt Vernon. Young of preceding on elm, Sept. 16

Menand, L. Albany. Icerya purchasi Mask., cottony cushion scale, on acacia, Feb. 25

Orthoptera

Lansing, *Mrs* **Abraham.** Albany. Panchlora hyalina Stoll., on book, Mar. 6

Gillett, J. R. Albany. Same as preceding, on apples, Mar. 26

Isoptera

Mare Co., A. T. De La. New York city. Termes flavipes Koll., white ant, adult, Feb. 3

Exchange

Diptera

CULICIDAE

Banks, C. S. Government Entomologist, Manila, P. I. Myzomyia ludlowii Theob., M. mangyana Banks, Myzorhynchus barbirostris V. d. W., M. vanus Walk., Stegomyia aurostriata Banks, S. persistans Banks, S. samarensis Ludl., Worcesteria grata Banks, Helecoetomyia pseudotaeniata Giles, Leucomyia cuneatus Theob., Culex fatigans Wied., C. microannulatus Theob., Mansonia uni-

formis Theob., Banksinella luteolateralis Theob., Finlaya aranetana Banks, F. poicilia Theob., Aedomyia squamipenna Arriz.

DOLICHOPODIDAE

Aldrich, J. M. Moscow, Idaho. Psilopodinus mundus Wied., Agonosoma filipes ? Loew, A. scintillans Loew, Mesorhaga albiciliata Ald., Diaphorus mundus Loew, D. opacus Loew, Asyndetus syntormoides Wheel., Chrysotus barbatus Loew, C. discolor Loew, C. picticornis Loew, Argyra robusta Jno., Leucostola cingulata Loew, Porphyrops effilatus Wheel., Syntormon affine Wheel., Neurigona carbonifer Loew, Medeterus aurivittatus Wheel., Hydrophorus philombrius Wheel., Scellus vigil O. S., Aphrosyllus praedator Wheel., Dolichopus acuminatus Loew, D. albicoxa Ald., D. detersus Loew, D. lobatus Loew, D. ovatus Loew, D. pugil Loew, D. setifer Loew, D. sexarticulatus Loew, D. setosus Loew, Gymnopternus crassicauda Loew, G. debilis Loew, G. frequens Loew, G. phyllophorus Loew, Hercostomus unicolor Loew, Tachytrechus vorax Loew, Pelastoneurus laetus Loew, P. lamellatus Loew, P. neglectus Wheel.

TABANIDAE

Hine, J. S. Columbus, O. Chrysops vittatus Wied., Tabanus fronto O. S., T. tener O. S., T. trispilus Wied.

Purchase

Heidemann, *Mrs* **Otto.** Washington, D. C.

Onion fly, Phorbia ceparum Meig., enlarged models representing the egg, maggot, puparium, adult and an infested onion

Cigar case bearer, Coleophora fletcherella Fern., an enlarged model representing the larva and its operations on an apple leaf

Kny-Scheerer Co. New York city

Honey bee, Apis mellifica Linn., life history group

European hornet, Vespa crabro Linn., life history group

Ground beetle, Calosoma sycophanta Linn., life history group

Corn stalk fly, Chlorops taeniopus Curtis life history (in alcohol)

Cabbage butterfly, Pieris rapae Linn., life history group

4 insects in amber

ZOOLOGY

Donation

Mammals

Robinson, *Major.* West Point. Cave rat, Neotoma pennsylvanica Stone, skins.......... 2

Richard, William. Cody, Wy. Long-tailed weasel, Putorius longicauda (Bon), skin.......... 1

Birds

Alexander, Charles P. Johnstown

Least flycatcher, Empidonax minimus Baird, eggs 4
Catbird, Dumetella carolinensis (Linn.), eggs 3
Robin, Planesticus migratorius (Linn.), eggs 5
Blue jay, Cyanocitta cristata (Linn.), eggs 5
Hermit thrush, Hylocichla guttata pallasii (Cab.), eggs .. 3
Kingfisher, Ceryle alcyon (Linn.), eggs 5
Brown thrasher, Toxostoma rufum (Linn.), eggs 3
Bluebird, Sialia sialis (Linn.), eggs 4

Ashbury, L. O. Auburn

Blackburnian warbler, Dendroica blackburniae (Gmel.), skin 1
Bay-breasted warbler, Dendroica castanea (Wils.), skin 1
Cerulean warbler, Dendroica cerulea (Wils.), skin 1
American redstart, Setophaga ruticilla (Linn.), skin 1
Scarlet tanager, Piranga erythromelas Vieill., skin 1

Eaton, E. H. Geneva. Sora, Porzana carolina (Linn.), mounted specimen 1

Judd, W. W. Albany

Song sparrow, Melospiza melodia (Wils.), nest and eggs 6
Robin, Planesticus migratorius (Linn.), nest and eggs ... 3

Klein, A. J. Albany. Red-shouldered hawk, Buteo lineatus (Gmel.), skins juv 3

Ward, *Dr* S. B. Albany

Broad-winged hawk, Buteo platypterus (Vieill.), mounted specimens 2
Wilson's snipe, Gallinago delicata (Ord.), mounted specimen 1
Sora, Porzana carolina (Linn.), mounted specimen 1
Pintail, Dafila acuta (Linn.), mounted specimen 1
Locn, Gavia immer (Brünn.), mounted specimen 1

Reptiles and batrachians

Alexander, Charles P. Johnstown

Brown snake, Storeria occipitomaculata (Storer) 1
Red eft, Diemictylus viridescens (Raf.) form miniatus (Raf.) 1
Two-lined salamander, Spelerpes bilineatus (Green) 4
Red-backed salamander, Plethodon cinereus erythronotus (Green) 1
Toad, Bufo lentiginosus (Shaw) juv 1

Haebler, *Dr* P. B. Albany. Hog-nosed snake, Heterodon platirhinus (Latreille) (melanistic) 1

Leighton, H. Albany. Ring-necked snake, Diadophis punctatus (Linn.) 1

Lodge, W. L. Albany

Brown snake, Storeria occipitomaculata (Storer) 1
Garter snake, Thamnophis sirtalis (Linn.) 1
Milk snake, Lampropeltis doliata triangula (Boie) ... 1
Tiger triton, Amblystoma tigrinum (Green) juv 1

Vrooman, I. H. jr. Albany
Dusky salamander, Desmognathus fusca (Raf.)........... 1
Two-lined salamander, Spelerpes bilineatus (Green)....... 3
Red-backed salamander, Plethodon cinereus erythronotus (Green).. 1

Arachnida, Myriapoda and Crustacea

Bean, *Dr* Tarleton H. Albany
Crawfish, Cambarus bartoni (Fabr.)......................... 2
Isopod, Mancasellus brachyurus (Haeger)............. 15
Dey Ermand, H. H. Albany. Heteropoda venatoria (Linn.).. 1
Lodge, W. L. Albany
Spider, Lycosa carolinensis Hentz........................ 1
Thousand-legged worm, Spirobolus marginatus (Say)...... 1
Miller, *Miss* Helen. Albany
Dolomedes tenebrosus Hentz.......................... 1
Epeira sclopetaria (Clerck)............................ 2
E. insularis Hentz.. 3
Vrooman, I. H. jr. Albany
Agelena naevia Bosc.................................... 2
Epeira displicata Hentz................................. 1
E. patagiata (Clerck)..................................... 1
Theridium tepidariorum Koch......................... 1
Ward, *Miss* Cornelia. Rochester
Epeira trifolium Hentz.................................. 1
Epeira patagiata (Clerck)............................. 1
Epeira domiciliorum Hentz............................. 1
Prothesima ecclesiastica Hentz........................ 1
Theridium tepidariorum Koch......................... 1
Pirata insularis Emerton............................... 1
Zabriskie, J. Z. Brooklyn. Pseudoscorpion, Chelifer muricatus, nest and molted skin................................ 1

Mollusca

Bean, *Dr* Tarleton H. Albany
Physa heterostropha (Say)............................. 3
Lymnaea decidiosa (Say).............................. 3
Zonitoides arboreus (Say)............................. 1

Purchase

Mammals

Elliott, Joseph. Beaver River. Porcupine, Erethizon dorsatus (Linn.) skins.. 4
Ward's Natural Science Establishment, Rochester. Black bear, Ursus americanus Pallas, group of......................... 4

Birds

Braislin, *Dr* **W. C.** Brooklyn

Kittiwake, Rissa tridactyla (Linn.), skins.................. 2
Great black-backed gull, Larus marinus Linn, skin............ 1
Ring-billed gull, Larus delawarensis Ord., skin.............. 1
American scoter, Oidemia americana Swains., skin......... 1
American coot, Fulica americana Gmel., skin................. 1
Red phalarope, Phalaropus fulicarius (Linn.), skin......... 1
Northern phalarope, Tobipes lobatus (Linn.), skin........... 1
Knot, Tringa canutus Linn., skin........................... 1
American golden plover, Charadrius dominicus Müll., skin 1
Night hawk, Chordeiles virginianus (Gmel.), skin.......... 1
Olive-sided flycatcher, Nuttallornis borealis (Swains.), skins 2
Wood pewee, Myiochanes virens (Linn.), skin.............. 1
Least flycatcher, Empidonax minimus Baird, skin............ 1
Fish crow, Corvus ossifragus Wilson, skin.................. 1
Starling, Sturnus vulgaris Linn., skin...................... 1
Bronzed grackle, Quisculus quiscula aeneus (Ridg.), skin. 1
American crossbill, Loxia curvirostra minor (Brehm), skins 2
Pine siskin, Spinus pinus (Wilson), skins.................. 2
Vesper sparrow, Pooecetes gramineus (Gmel.), skin...... 1
Ipswich sparrow, Passerculus princeps (Maynard), skins.. 2
Grasshopper sparrow, Coturniculus savannarum australis (Maynard), skin... 1
Chipping sparrow, Spizella passerina (Bechstein), skin..... 1
Field sparrow, Spizella pusilla (Wilson), skin.............. 1
Northern shrike, Lanius borealis Vieill., skin................ 1
White-eyed vireo, Vireo griseus (Boddaert), skins........... 2
Blue-winged warbler, Helminthophila pinus (Linn.), skins. 2
Tennessee warbler, Helminthophila peregrina (Wilson), skin 1
Blackburnian warbler, Dendroica blackburniae (Gmel.), skin 1
Palm warbler, Dendroica palmarum (Gmel.), skins.......... 2
Connecticut warbler, Oporornis agilis (Wilson), skins..... 2
American pipit, Anthus rubescens (Tuntsall), skins.......... 2
Catbird, Dumetella carolinensis (Linn.), skin............. 1
Brown thrasher, Toxostoma rufum (Linn.), skin.......... 1
Carolina wren, Tryothorus ludovicianus (Lath.), skins.. 2
House wren, Troglodytes aedon Vieill., skin................ 1
Brown-headed nuthatch, Sitta pusilla Lath., skin............ 1
Tufted titmouse, Baeolophus bicolor (Linn.), skin......... 1
Carolina chickadee, Penthestes carolinensis (Audubon), skin 1
Wood thrush, Hylocichla mustelina (Gmel.), skin........ 1
Wilson's thrush, Hylocichla fuscescens (Steph.), skin.... 1
Grey-cheeked thrush, Hylocichla aliciae (Baird), skin..... 1

Bicknell's thrush, Hylocichla aliciae bicknelli (Ridg.), skin ... 1
Olive-backed thrush, Hylocichla ustulata swainsonii (Cab.) skins ... 2

Worthen, C. K. Warsaw, Ill.
Great skua, Megalestris skua (Brünn.), skins ... 2
Roseate tern, Sterna dougalli Montag., skin ... 1
Booby, Sula leucogastra (Boddaert), skin ... 1
Burrowing owl, Speotyto cunicularia hypogaea (Bonapart), skin ... 1

Reptiles

Ward's Natural Science Establishment, Rochester
Copperhead, Ancistrodon contortrix (Linn.), cast ... 1
Hog-nose snake, Heterodon platirhinus (Latreille), cast ... 1
Green snake, Liopeltis vernalis (Harlan), cast ... 1
Milk snake, Lampropeltis doliata triangula (Boie), cast 1
Dusky garter snake, Thamnophis sirtalis obscura (Cope), cast ... 1
Ribbon snake, Thamnophis saurita (Linn.), cast ... 1
Ring-neck snake, Diadophis punctatus (Linn.), cast ... 1

Invertebrates

Ward's Natural Science Establishment, Rochester
Portuguese man-of-war, Physalia arethusa (Til.), glass model 1
Actinia, Mesembrianthemum rubra G., glass model ... 1
Corallium rubrum Lam., glass model ... 1

Collection

Mammals

Members of the museum staff, *Mr* **E. Seymour Woodruff** *and Mr* **I. H. Vrooman jr.** Albany
White-footed mouse, Peromyscus leucopus noveboracensis (Fisch.), skin ... 1
Northern white-footed mouse, Peromyscus maniculatus gracilis (Leî. C.), skins ... 4
Evotomys gapperi (Vigors), skin ... 1
Microtus pennsylvanicus (Ord.), skin ... 1
Canadian porcupine, Erethizon dorsatus (Linnaeus), skin ... 1
Muskrat, Fiber zibethicus Linnaeus, skin ... 1
Woodchuck, Arctomys monax (Linnaeus), skin ... 1
Short-tailed shrew, Blarina brevicauda (Say), skin ... 1
New York weasel, Putorius noveboracensis Emmons, skin ... 1
Little red bat, Lasiurus borealis (Müller), skin ... 1

Birds

Herring gull, Larus argentatus Pontop., skin 1
Hooded merganser, Lophodytes cucullatus (Linn.), skin .. 1
American golden-eye, Clangula clangula americana Faxon, skin 1
Green heron, Butorides virescens (Linn.), skin 1
Woodcock, Philohela minor (Gmel.), skins 2
Black-bellied plover, Squatarola squatarola (Linn.), skin 1
Broad-winged hawk, Buteo platypterus (Vieill.), skin 1
Belted kingfisher, Ceryle alcyon (Linn.), skins 2
Hairy woodpecker, Dryobates villosus (Linn.), skins 3
Yellow-bellied sapsucker, Sphyrapicus varius (Linn.), skin 1
Flicker, Colaptes auratus luteus Bangs., skin 1
Phoebe, Sayornis phoebe (Lath.), skins 2
Olive-sided flycatcher, Nuttallornis borealis (Swains.), skins 2
Yellow-bellied flycatcher, Empidonax flaviventris Baird, skins 2
Alder flyctcher, Empidonax traillii alnorum Brewster, skin 1
Least flycatcher, Empidonax minimus Baird, skin 1
Blue jay, Cyanocitta cristata (Linn.), skins 2
Canada jay, Perisoreus canadensis (Linn.), skins 2
Red-winged blackbird, Agelaius phoeniceus (Linn.), skin .. 1
Rusty blackbird, Euphagus carolinus (Müll.), skin 1
American goldfinch, Astragalinus tristis (Linn.), skins 2
Snowflake, Plectrophenax nivalis (Linn.), skins 3
Grasshopper sparrow, Coturniculus savannarum australis (Maynard), skin 1
Henslow's sparrow, Ammodramus henslowii (Aud.), skin. 1
White throated sparrow, Zonotrichia albicollis (Gmel.), skins 2
Chipping sparrow, Spizella passerina (Bechstein), skins 2
Slate-colored junco, Junco hyemalis (Linn.), skin 1
Lincoln's sparrow, Melospiza lincolnii (Aud.), skins 2
Fox sparrow, Passerella iliaca (Merr.), skin 1
Towhee, Pipilo erythrophthalmus (Linn.), skin 1
Rose-breasted grosbeak, Zamelodia ludoviciana (Linn.), skins 2
Scarlet tanager, Piranga erythromelas Vieill., skin 1
Barn swallow, Hirundo erythrogaster Bodd., skin 1
Tree swallow, Iridoprocne bicolor (Vieill.), skins 3
Northern shrike, Lanius borealis Vieill., skin 1
Red-eyed vireo, Vireosylva olivacea (Linn.), skin 1
Philadelphia vireo, Vireosylva philadelphica (Cassin), skin 1
Blue-headed vireo, Lanivireo solitarius (Wilson), skins 2
Nashville warbler, Helminthophila rubricapilla (Wilson), skin 1

Black-throated blue warbler, Dendroica caerulescens (Gmel.), skin	1
Myrtle warbler, Dendroica coronata (Linn.), skin	1
Magnolia warbler, Dendroica magnolia (Wilson), skins	3
Cerulean warbler, Dendroica caerulea (Wilson), skin	1
Bay-breasted warbler, Dendroica castanea (Wilson), skin	1
Blackburnian warbler, Dendroica blackburniae (Gmel.), skin	1
Black-throated green warbler, Dendroica virens (Gmel.), skins	2
Ovenbird, Seiurus aurocapillus (Linn.), skins	2
Maryland yellowthroat, Geothlypis trichas (Linn.), skins	4
Canadian warbler, Wilsonia canadensis (Linn.), skins	3
Brown thrasher, Toxostoma rufum (Linn.), skins	2
White-breasted nuthatch, Sitta carolinensis Lath., skin	1
Red-breasted nuthatch, Sitta canadensis Linn., skins	2
Golden-crowned kinglet, Regulus satrapa Licht., skin	1
Wood thrush, Hylocichla mustelina (Gmel.), skin	1
Gray-cheeked thrush, Hylocichla aliciae (Baird), skin	1
Olive-backed thrush, Hylocichla ustulata swainsonii (Cab.), skins	2

Batrachians

Salamander, Plethodon cinereus cinereus (Green)	3
Red-backed salamander, Plethedon cinereus erythronotus (Green)	2
Striped salamander, Spelerpes bilineatus (Green)	2
Dusky salamander, Desmognathus fusca (Raf.)	6
Red eft, Diemictylus viridescens miniatus (Raf.)	2

Arachnids

Tetragnatha laboriosa Hentz	1
Tetragnatha grallator Hentz	1
Epeira silvatica Emerton	3
Argiope riparia (Hentz)	1
Argiope transversa (Hentz)	1
Lycosa nidicola Emerton	1
Lycosa frondicola Emerton	1
Lycosa communis Emerton	1
Pirata montana Emerton	2
Pirata insularis Emerton	2
Agelena naevia Basc	3
Linyphia marginata Koch	6
Theridium frondeum Hentz	1
Epiblemum scenicum (Clerck)	1
	341

Many small spiders not yet identified

The Shufeldt collection of avian osteology presented by *Dr* **R. W. Shufeldt,** New York

American eared grebe, *Colymbus nigricollis californicus* (Heerm.)	1 skeleton
Red-throated loon, *Gavia stellata* (Pontop.)	1 hyoid
Razor-billed auk, *Alca torda* Linn.	1 skeleton
Ring-billed gull, *Larus delawarensis* Ord	1 "
Bonaparte gull, *Larus philadelphia* (Ord.)	1 "
Short-tailed albatross, *Diomedea albatrus* Pall.	2 skulls
Albatross species ?	1 misc. bones
Pintado petrel, *Daption capensis* (Linn.)	1 skeleton
Red-billed tropic-bird, *Phaethonaethereus* Linn.	4 "
Florida cormorant, *Phalacrocorax auritus floridanus* (Aud.)	1 hyoid
Mallard, *Anas platyrhynchos* Linn.	3 skulls
Green-winged teal, *Nettion carolinensis* (Gmel.)	1 skeleton
	4 skulls
Blue-winged teal, *Querquedula discors* (Linn.)	1 sternum
Shoveler, *Spatula clypeata* (Linn.)	1 "
Rufous-crested duck, *Netta rufina* Pall.	1 skeleton
Canada goose, *Branta canadensis* (Linn.)	1 "
Trumpeter swan, *Olor buccinator* (Rich.)	1 skull
Wild duck species ?	1 "
Glossy ibis, *Plegadis autumnalis* (Hasselq.)	1 skeleton
Great blue heron, *Ardea herodias* Linn.	1 "
Little blue heron, *Florida caerulea* (Linn.)	1 "
Green heron, *Butorides virescens* (Linn.)	1 "
California clapper rail, *Rallus obsoletus* Ridgw.	2 "
Clapper rail, *Rallus crepitans* Gmel.	1 "
Corn crake, *Crex pratensis* Bechs.	1 "
American coot, *Fulica americana* Gmel.	1 sternum
Wilson snipe, *Gallinago delicata* (Ord.)	1 skull
Long-billed dowitcher, *Macrorhampus scolopaceus* (Say)	1 "
Least sandpiper, *Pisobia minutilla* (Vieill.)	2 skeletons
Solitary sandpiper, *Helodromas solitarius* (Wils.)	2 "
Long-billed curlew, *Numenius americanus* (Bechs.)	1 "
	3 skulls
	1 sternum
Black-bellied plover, *Squatarola squatarola* (Linn.)	1 skeleton
Mountain plover, *Podasocys montanus* (Towns.)	1 "
Surf bird, *Aphriza virgata* (Gmel.)	1 "
Black turnstone, *Arenaria melanocephala* (Vig.)	1 "
Texan quail, *Colinus virginianus texanus* (Lawr.)	2 sterna
California partridge, *Lophortyx californica* (Shaw.)	1 skeleton

Canada grouse, Canachites canadensis (Linn.)	1 skeleton
	1 misc. bones
Ruffed grouse, Bonasa umbellus (Linn.)	2 skeletons
	1 misc. bones
Welch ptarmigan, Lagopus welchi (Brewst.)	1 skeleton
Sharp-tailed grouse, Pediocaetes phasianellus (Linn.)	1 skull
Sage grouse, Centrocercus urophasianus (Bonap.)	1 "
Wild turkey, Meleagris gallopavo Linn.	2 skulls
Series of wild and domestic turkeys	10 "
Jungle fowl, Gallus bankiva Temm.	2 skeletons
Domestic fowl	2 skulls
Chachalaca, Ortalis vetula maccalli Baird	1 skeleton
Mourning dove, Zenaidura macroura carolinensis (Linn.)	2 "
White-fronted dove, Leptotilta fulviventris brachyptera (Salv.)	1 "
White-winged dove, Melopelia asiatica (Linn.)	1 skeleton
Domestic pigeon	1 "
Turkey vulture, Cathartes aura septentrionalis (Wied.)	2 skeletons
Sarcorhamphus gryphus (Linn.)	1 hyoid
Swallow-tailed kite, Elanoides forficatus (Linn.)	1 sternum
Marsh hawk, Circus hudsonius (Linn.)	4 skeletons
	1 skull
Sharp-shinned hawk, Accipiter velox (Wils.)	3 skeletons
	1 sternum
Cooper's hawk, Accipiter cooperi (Bonap.)	2 skeletons
	1 sternum
American goshawk, Astur atricapillus (Wils.)	1 hyoid
Western red-tail, Buteo borealis calurus (Cass.)	3 skeletons
Mexican goshawk, Asturina plagiata Schlegel	1 "
American rough-legged hawk, Archibuteo lagopus sanctijohannis (Gmel.)	1 "
Golden eagle, Aquila chrysaetos (Linn.)	1 sternum
White gyrfalcon, Falco islandus Brünn.	1 skull
Prairie falcon, Falco mexicanus Schlegel	1 skeleton
Duck hawk, Falco peregrinus anatum (Bonap.)	1 hyoid
Pigeon hawk, Falco columbarius Linn.	4 skeletons
Sparrow hawk, Falco sparverius Linn.	5 "
	1 sternum
American osprey, Pandion haliaëtus carolinensis (Gmel.)	1 skeleton
American barn owl, Aluco pratincola (Bonap.)	1 misc. bones
American long-eared owl, Asio wilsonianus (Less.)	2 skeletons
Richardson owl, Glaux funerea richardsoni (Bonap.)	1 sternum
Saw-whet owl, Glaux arcadica (Gmel.)	1 "
	1 hyoid

Texas screech owl, Otus asio maccalli (Cacc.)	1 sternum
Great horned owl, Bubo virginianus (Gmel.)	1 sternum
Snowy owl, Nyctea nyctea (Linn.)	2 hyoids
Hawk owl, Surnia ulula (Linn.)	5 legs
	2 hyoids
Burrowing owl, Speotyto cunicularia hypogoea (Bonap.)	1 skeleton
Burrowing owl, Speotyto sp. ?	1 misc. bones
Elf owl, Micropallas whitneyi Cooper	2 skeletons
Carolina paroquet, Conuropsis carolinensis (Linn.)	2 "
Road runner, Geococcyx californicus (Less.)	3 "
Yellow-billed cuckoo, Coccyzus americanus (Linn.)	1 "
Cuckoo, Cucullus canorus Linn.	1 "
Coccystes glandarius Linn.	1 "
Nanondes undulatus Vig. & Hors.	1 hyoid
Unidentified parrot	1 skeleton
Hairy woodpecker, Dryobates villosus (Linn.)	1 "
Harris woodpecker, Dryobates villosus harrisi (Aud.)	2 "
	1 hyoid
Gairdner woodpecker, Dryobates pubescens gairdneri (Aud.)	2 skeletons
Nuttall woodpecker, Dryobates nuttalli (Gamb.)	1 sternum
White-headed woodpecker, Xenopicus albolarvatus (Cass.)	1 "
Red-naped sapsucker, Sphyrapicus varius nuchalis Baird	2 skeletons
Williamson sapsucker, Sphyrapicus ruber thyroides (Cass.)	1 "
Pileated woodpecker, Phloeotomus pileatus (Linn.)	1 "
	3 sterna
Red-headed woodpecker, Melanerpes erythrocephalus (Linn.)	2 skeletons
Californian woodpecker, Melanerpes formicivorus bairdi Ridgw.	1 sternum
Lewis woodpecker, Asyndesmus lewisi Riley	8 skeletons
Red-bellied woodpecker, Centurus carolinus (Linn.)	1 skeleton
Gila woodpecker, Centurus uropygialis (Baird)	1 "
Red-shafted flicker, Colaptes cafer collaris (Vig.)	1 "
Green woodpecker, Picus viridis Linn.	1 hyoid
Dryobates sp. ?	1 skeleton
Nighthawk, Chordeiles virginianus (Gmel.)	1 skull
Western nighthawk, Chordeiles virginianus henryi (Cass.)	1 lot of bones
Texan nighthawk, Chordeiles acutipennis texensis (Lawr.)	2 skeletons

White-throated swift, Aeronautes melanoleucus Baird	2 skeletons
Blue-throated hummingbird, Cyanolaemus clemensiae (Less.)	2 sterna
Black-chinned hummingbird, Trochilus alexandri Bourc. & Muls	1 sternum
Costa hummingbird, Calypte costae (Bourc.)	1 "
Anna hummingbird, Calypte anna (Less.)	2 sterna
Broad-tailed hummingbird, Selasphorus platycercus (Swains.)	1 sternum
Rufous hummingbird, Selasphorus rufus (Gmel.)	10 skeletons
Calliope hummingbird, Stellula calliope Gould	3 "
	2 sterna
Broad-billed hummingbird, Cynanthus latirostris Swains	1 sternum
Kingbird, Tyrannus tyrannus (Linn.)	1 skeleton
Crested flycatcher, Myiarchus crinitus (Linn.)	2 "
Say phoebe, Sayornis saya (Bonap.)	1 "
Vermilion flycatcher, Pyrocephalus rubineus mexicanus (Scl.)	1 "
American magpie, Pica pica hudsonia (Sab.)	1 "
Blue jay, Cyanocitta cristata (Linn.)	1 skull
Steller jay, Cyanocitta stelleri (Gmel.)	1 skeleton
Blue-fronted jay, Cyanocitta stelleri frontalis (Ridgw.)	1 sternum
Long-crested jay, Cyanocitta stelleri diademata (Bonap.)	1 skeleton
Woodhouse jay, Aphelocoma woodhousei (Baird)	1 "
California jay, Aphelocoma californica (Vig.)	1 "
American raven, Corvus corax Linn	3 skeletons
	1 skull
American crow, Corvus brachyrhynchos Brehm	2 "
	1 sternum
Lamprocorax panayensis (Cab.)	2 skeletons
Pinon jay, Cyanocephalus cyanocephalus Wied	7 "
	1 sternum
Starling, Sturnus vulgaris Linn	1 skeleton
Red-winged blackbird, Agelaius phoeniceus (Linn.)	1 "
	10 skulls
Western meadowlark, Sturnella neglecta (Aud.)	1 skeleton
Scott oriole, Icterus parisorum Bonap	1 sternum
Hooded oriole, Icterus cucullatus sennetti Ridgw	1 skeleton
Orchard oriole, Icterus spurius (Linn.)	1 "
Bullock oriole, Icterus bullocki (Swains.)	1 "
Oriolus chinensis Linn	1 "

Sarcops calvus (Linn.)	3 skeletons
Sarcops melanonotus Grant	1 “
Brewer blackbird, Euphagus cyanocephalus (Wagl.)	1 “
	1 sternum
Western evening grosbeak, Hesperiphona vespertina montana (Ridgw.)	10 skeletons
Cassin purple finch, Carpodacus cassini Baird	4 “
American crossbill, Loxia curvirostris minor (Brehm.)	3 “
Redpoll, Acanthis linaria (Linn.)	1 “
Pine siskin, Spinus pinus (Wils.)	1 “
	1 skull
Gambel sparrow, Zonotrichia leucophrys gambeli (Nutt.)	1 skeleton
Brewer sparrow, Spizella breweri Cass	1 sternum
Black-chinned sparrow, Spizella atrogularis (Cab.)	1 “
Bell sparrow, Amphispiza belli (Cass.)	1 “
Spurred towhee, Pipilo maculatus montanus (Swarth)	1 skeleton
Green-tailed towhee, Pipilo chlorurus (Towns.)	1 “
Cardinal, Cardinalis cardinalis (Linn.)	2 “
Black-headed grosbeak, Zamelodia melanocephala (Swains.)	1 “
Blue grosbeak, Guiraca caerulea (Linn.)	1 “
Lark bunting, Calamospiza melanocorys Stejn	1 “
	1 sternum
Louisiana tanager, Piranga ludoviciana (Wils.)	1 “
Summer tanager, Piranga rubra (Linn.)	1 skeleton
Barn swallow, Hirundo erythrogaster (Bodd.)	3 “
Bank swallow, Riparia riparia (Linn.)	2 “
Bohemian waxwing, Bombycilla garrula (Linn.)	1 sternum
Cedar waxwing, Bombycilla cedrorum Vieill	2 skeletons
Phainopepla, Phainopepla nitens (Swains.)	1 sternum
Northern shrike, Lanius borealis Vieill	1 skeleton
White rumped shrike, Lanius ludovicianus excubitorides (Swains.)	4 “
	1 skull
Philadelphia vireo, Vireosylva philadelphica (Cass.)	1 hyoid
Gray vireo, Vireo vicinior Coues	1 sternum
Cape May warbler, Dendroica tigrina (Gmel.)	1 hyoid
Audubon warbler, Dendroica auduboni (Towns.)	1 sternum
Bay-breasted warbler, Dendroica castanea (Wils.)	1 hyoid
Black-throated gray warbler, Dendroica nigrescens (Towns.)	1 sternum
Canadian warbler, Wilsonia canadensis (Wils.)	1 hyoid
American redstart, Setophaga ruticilla (Linn.)	1 skeleton

American dipper, Cinclus mexicanus unicolor (Bonap.)	2 skeletons
Sage thrasher, Oroscoptes montanus (Towns.)	1 sternum
Mockingbird, Mimus polyglottos (Linn.)	1 "
Catbird, Dumetella carolinensis (Linn.)	1 skull
Brown thrasher, Toxostoma rufum (Linn.)	1 skeleton
Palmer thrasher, Toxostoma curvirostre palmeri (Coues)	1 "
Leconte thrasher, Toxostoma lecontei (Lawr.)	2 sterna
Cactus wren, Heleodytes brunneicapillus couesi (Sharpe)	1 skeleton
Rock wren, Salpinctes obsoletus (Say)	1 "
Parkman wren, Troglodytes aedon parkmani (Aud.)	1 "
Brown creeper, Certhia familiaris americana (Bonap.)	1 "
Slender-billed nuthatch, Sitta carolinensis aculeata (Cass.)	3 "
Pygmy nuthatch, Sitta pygmaea Vig.	8 "
Gray titmouse, Baeolophus inornatus griseus (Ridgw.)	4 "
Carolina chickadee, Penthestes carolinensis (Aud.)	1 "
Mountain chickadee, Penthestes gambeli (Ridgw.)	1 skull
	2 sterna
Chestnut-backed chickadee, Penthestes rufescens (Towns.)	1 skeleton
Pallid wren-tit, Chamaea fasciata phaea Osgood	1 "
Lead-colored bush-tit, Psaltriparus plumbeus Baird	2 "
Verdin, Auriparus flaviceps (Sund.)	2 "
	1 sternum
Accentor modularis (Linn.)	2 skeletons
Golden-crowned kinglet, Regulus satrapa Licht.	1 skeleton
Ruby-crowned kinglet, Regulus calendula (Linn.)	2 skeletons
Townsend solitaire, Myadestes townsendi (Aud.)	5 "
American robin, Planesticus migratorius (Linn.)	1 sternum
Western robin, Planesticus migratorius propinquus (Ridgw.)	1 skeleton
	1 skull
Mountain bluebird, sialia currucoides (Bechs.)	1 sternum
Unidentified	8 sterna
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ARCHEOLOGY

Purchase

Griffiths, H. Ripley
- Stone bowl 1
- Spears 6
- Celts 2

Jimerson, George. Irving
- Gages for splitting basket splints 6

Kittle, D. B. Lawton
- Leggings .... pair, 1
- Bows 6
- Red mask 1
- Beaded belt 1
- Mask, semilunar eyes 2
- Ceremonial masks 3
- Tools used by brooch maker .. 140
- Silver worker's table 1
- Husk tray 1
- Deer bone buttons in process of making 8
- Husk sleeping mat 1
- Manuscript notes 2

Dennes, Charles. Irving
- Twisted axe 1

Reed, W. L. Syracuse
- Jesuit medal 1

Cornplanter, E. Lawton
- Medicine packet 1
- Books from Cattaraugus Mission Press 2

Parker, F. E. New York
- Haida pipe 1
- Medicine rattle 1
- Moccasins .... pair, 1
- Feather fan 1
- Husk ceremonial 1

Benedict, M. Lake George
- Algonquin beaded belt 1
- Roll of splints, Algonquin 1
- Basket " 1
- Gages, Algonquin 2

Mohawk, Nancy. Lawton
- Gage, Seneca 1
- Ring " 1
- Manuscripts, etc 2

Thomas, Baptist
- Manuscript 1

Snyder, Peter. Versailles
- Burden strap in process of manufacture 1
- Roll of elm bark cord 1
- Roll of elm bark shreds 1
- String, sinew 1
- Colored moose hair, packages. 12
- Native hemp (package) 1

Kennedy, Irving
- Pots from graves (4 broken) 6
- Pipes 2
- Iron knives 2
- Tomahawk iron 1
- Stone axe (broken) 1
- Woven basket from grave 1
- Hammer stone 1
- Beads 150
- Pipestone beads 25
- Shell beads 25
- Buckskin and copper beads ... 20
- Copper beads on string 125
- Pipestone beads 6
- Buckskin fragment preserved by contact with copper 1
- Turtleshell box 1
- Bone comb 1
- Stone charm 1
- Brass kettle and gourd 2
- Copper bell 1
- Iron rings 2
- Pestle 1
- Bone tubes 10
- Arrow heads 25

Excavation

Parker A. C. High Banks site near Irving

Arrow heads, general layer	14

From Lodge site 1

Pottery, bear's head effigy	1
Iron chisel	1
Pipe stem, coiled decoration	1
Pipe stem fragment	1
Perforated dog tooth	1
Pot fragments ...bag,	1
Iron point	1
Flint scrapers	4
Pipe stem, coiled serpent	1
Thin scraper	1
Flint reject	2
Triangular flint points	5
Notched deer incisor	1
Pipe bowl fragment	1
Broken flint points	11
Scrapers	2
Flint reject	1
Miscellaneous objects in bag	14
Miscellaneous objects in box	7
Pipe stems	3
Piece of worked brass	1
Notched point	1
Pipe stem	1
Pipe bowl fragment	1
Triangular brass arrow point	1
Scraper	1
Oval flint knife	1
Potsherd	1
Bone awl	1
Bone flaking tool	1
Flint points	[illegible]
Cylindrical bead	1
Worked bone	1
Bone bead	1
Bone punch	1
Worked bird bone	1
Rough knife, chert	1
Triangular point	1
Scraper	1
Part of brass earring	1
Wampum shell cone	1

Lodge site 2

Incised bone tube	1
Bone handle	1
Worked tarsal bone	1
Chert knife	1
Worked point	1
Pipe bowl, square top	1
Celt, adzlike	1
Brass ornament	1
Triangular point	1
Long triangular point	1
Brass ornament	1
Copper knife	1
Arrowhead	1
Pipe bowl fragments	2
Pipe stem, serpent decoration	1
Brass triangle	1
Brass point	1
Gray chert point	1
Brass arrow points	2
Bone tube, 7 and 13 tally marks	1
Disk wampum bead	1
Incised bone bead	1
Polished tube of bone	1
Rude bone face	1
Pottery pipe face	1
Broken stem of flat pipe	1
Shell bead	1
Incised shell	1
Chert knife	1
Disk bead	1
Pipe stem	1
Small objects in bag	20
Potsherd	1

Lodge site 3

Worked bear's molar	1
Chert scraper, handled	1
Pipe bowl, duck effigy	1
Chunk of iron	1
Pot rim, sherd	1
Worked shell	1
Scraper	1
Pipe stem	1
Knife blade	1

Pipe stems	3
Flint point	1
Brass chopping knife	1
Pipe stem tips	4
Brass lock shield	1
Bowl of small pipe	1

Lodge site 4

Bowl of small pipe	1
Bowl of red clay pipe	1
Piece of worked antler	1
Worked object of ankylosed tarsus	1
Fragments of European trade pipe	2
Flint arrow points	10
Pipe stem fragments	2
Rim of small pot	1
Shell object	1
Bear tusks	3
Pipe stem tips	3
Pipe stem fragments	3
Rude flints	3
Edge of brass chisel	1
Serrated brass strip	1
Hematite nodule	1
Fossil, worked	1
Large piece of worked brass	1
Pieces of worked brass	
Square of brass, perforated	1
Triangular brass arrow points	2
Pieces of worked brass	2
Iron knife, no. 61	1
Perforated shells	4
Pipe bowl fragments	2
Jasper nodule, split	1
Brass cone	1
Pot rim fragments	4
Fragment bead tube	1
Knife blade, iron	1
Antler points	2
Naturally perforated stone	1
Pottery face from pipe bowl	1
Polished bone tube	1
Owl's head effigy from pipe	1
Edged stone	1
Pot rim fragment	1
Worked fish bone	1
Elk tooth	1
Pipe bowl fragments	2
Part of brass arm band	1
Flint arrow point	1
Part of pipe bowl	1
Pot rims	6
Scrapers	6
Disk of brass	1
Flint points	10
Pot rim	1
Worked sheet brass	1
Pipe bowl	1
Bone bead	1

Lodge site 5

Curved scraper	1
Bone tubes	2
Pipe bowl	1
Pipe neck	1
Flint knife	1
Worked bone	1
Miscellaneous objects in bag	14
Wampum bead, "Roanoke"	1

General layer

Potsherds	13
Net sinker	1
Arrow points	6
Pot bottom	2
Bone beads	6
Antler	1
Pipe bowl fragments	6
Pipe stem	1
Worked brasses	4
Marine shell, venus	1
Small bones.....boxes,	5
Unnumbered specimens, mostly potsherds, in box	120

West Rush

Box containing skeleton	1
Celts	3
Arrow points	52
Fragments of human bones	12
Pieces of pottery	25
String of shell beads	1

Dresden

Fragments of pottery	82
Arrow points	14
Miscellaneous	54

Pompey hill

Arrow points	19
Pottery in bag	1
Animal bones in bag	1
Human phalanx, incised	1

Ripley

Brown sandstone pipe	1
Bone beads	7
Crushed pot	1
Crushed tortoise shell	1
Skeleton, broken	1
Skeleton of child, broken	1
Broken bone comb, fork type	1
Bone bead	1

ONE HUNDRED YEARS OF NEW YORK STATE GEOLOGIC MAPS 1809-1909

BY HENRY LEIGHTON

In geology as in other sciences, no satisfactory understanding of the subject can be acquired without a knowledge of the history of its development. As Geikie says "it is eminently useful, now and then, to pause in the race, and to look backward over the ground that has been traversed, to mark the errors as well as the successes of the journey."

We have thought it of interest to review briefly the development of geology in New York State as evidenced by the published maps, and to publish a list of such maps arranged in chronological order and indexed; this list not only to serve as a reference index to all geological maps of the State but, as well, to show briefly the development of the science of geology in the State.

For the clear interpretation of the geology of a region, both in the distribution and structural features of its rocks, geologic maps are almost indispensable as an accompaniment to a written description. This fact was comprehended by the very early observers, and even before geology as a science was recognized, geologic or, more correctly, mineralogic maps were drawn. By all writers the credit for the publication of the first map showing geological features has been given to Jean Etienne Guettard who in 1751[1] issued a map of Paris and its environs. This was more of a mineralogic than a geologic map, its author seemingly having no conception of geological structure or sequence of formations. Guettard, unlike many scientists of his time and many more following him, was not of a speculative turn of mind, but believed strongly in observation as the best means of deriving important scientific truths. Originally a botanist, in his botanical excursions he became interested in the minerals and fossils he came across, and soon became convinced of the fact that minerals and fossils were not promiscuously distributed over and through the rocks but were arranged in definite bands.

He then conceived the idea[2] of fixing his observations by the use of a map showing the mineral and fossil localities, which were indi-

[1] Mem. Acad. Roy. Sciences, France. 1751.

[2] A similar plan, although probably unknown to Guettard, was proposed in a paper presented before the Royal Society of London in 1683.

cated by broad divisions or bands. Of these bands, there were three: the Sandy band, the Marly band and the Schistose or Metalliferous band. Although rough in outlines, this map even yet indicates in a general way the character of the rocks of the Paris basin. His work on this and several other maps attracted considerable attention at the time and the Academy of Science[1] stated that the work "opens up a new field for geographers and naturalists, and forms, so to speak, a link between two sciences which have hitherto been regarded as entirely independent of each other." Geikie[2] from whom these facts in regard to Guettard's work have been taken, says that this "gifted Frenchman" may be called the father of all the national geological surveys which have been instituted by the various civilized nations of the old and the new worlds.

The earliest map in colors, showing the aereal distribution of rocks was that of J. F. W. Charpentier, of the Mining School at Freiberg. This was published in 1778 at Leipsig, accompanying his *Mineralogische Geographie der Chursachsischen Lande,* and the distribution of gneiss, schist, loam, granite, limestone etc. was indicated by the use of eight tints.[2]

Previous to the year 1809 a few sketches concerning the geology of the United States had appeared, several of them dealing with New York State. The first definite geological mapping, however, was the work of William McClure who has been termed by various writers "The father of American Geology," "the William Smith of America," etc. This map was a hand-colored geologic chart of the United States east of the Mississippi, and was published with his paper on *Observations on the Geology of the United States,* in the Transactions of the American Philosophical Society of Philadelphia. Appearing when the influence of Werner and his classifications were at their hight and Hutton's more rational views had not yet been accepted by the majority, it strongly favored the Wernerian classification, the rocks being indicated in four colors called Primitive, Transition, Secondary or Floetz, and Alluvial.

Although crude in all details and but a poor substitute for the later maps of the United States, when one recalls that the science was still in its infancy, that the stratigraphic studies of Murchison and others were still in the future, that petrography had but recently become a science, he can not but marvel at the results achieved. Then, too, McClure, in common with all the geological

[1] Mem. Acad. Roy. Sciences, France. 1751; Jour. p. 105.
[2] Geikie, Founders of Geology, p. 22.

pioneers in the United States, had to contend with a woeful lack of facilities. As has been said by his biographer, " He went forth with his hammer in hand and his wallet on his shoulder, pursuing his researches in every direction, often amid pathless tracts and dreary solitudes, until he had crossed and recrossed the Allegheny mountains no less than 50 times. He encountered all the privations of hunger, thirst, fatigue and exposure, month after month and year after year until his indomitable spirit had conquered every difficulty and crowned his enterprise with success." On the map, the distribution of the formations in New York State is given as follows: the Primitive appears as a strip in southeastern New York; the Transition as a strip northwest of the Primitive extending from Hudson southwest to the State line; the Secondary or Floetz, as covering all western and central New York, bounded on the north by the Mohawk; the Alluvial, on the southern half of Long Island.

An interesting fact brought out by McClure's investigations was the occurrence of salt springs and gypsum beds in eastern Tennessee and as far north as Oneida lake, N. Y. He mapped these beds in Tennessee only, but says, " it is probable that this formation is on the same great scale which is common to all the other formations on this continent: at least rational analogy supports the supposition, and we may hope one day to find, in abundance, these two most useful substances which are generally found mixed or near each other." This indicates the keen insight of this early geologist in foreseeing the valuable beds of salt and gypsum discovered since then in our Silurian strata. This same map and text was published in a French journal in 1811 and a reprint of it may be found in the report of the United States National Museum (for 1904) 1906, facing page 189.

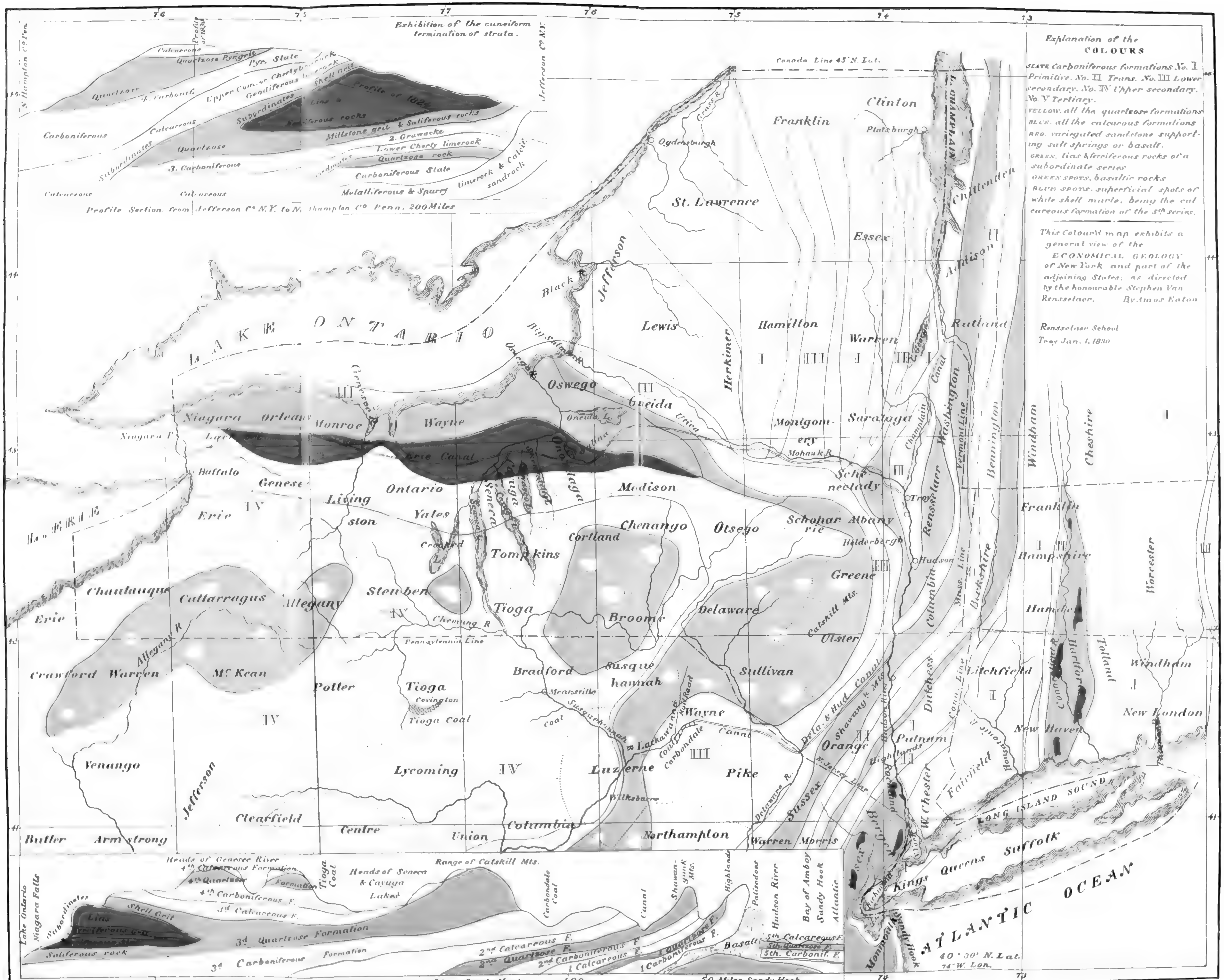
Mr McClure was never satisfied with this map on account of the poor base map on which he represented his geological features. So after traveling in Europe and making further excursions throughout the United States, he revised and published it in much better shape in 1818. Regarding New York State he says, " During an excursion last summer an opportunity was afforded of ascertaining and extending the limits of the transition in the states of Pennsylvania and New York, as well as the boundary of the great primitive formation, north of the Mohawk, and fixing the limits of the transition on Lake Champlain and in the state of Vermont with more precision." The principal changes on the New York map are the coloring of a large portion of the Adirondacks as

Primitive, an extension of the Transition up the east side of the Hudson into Washington county, and the extension of the green strip, representing salt and gypsum deposits, as far north as Schoharie county.

The sections accompanying this map are divided into the same formations and show no very definite idea of the correct structure of the region.

The year 1816 brought into the arena of geologic work a man whose work was to have a profound influence on the scientific thought of his time and country. This man was Amos Eaton. Born in Chatham in 1776, he pursued the study and practice of law till the year 1816 when, although 40 years of age, he became interested in the teachings of Professor Silliman at Yale, relinquished his law practice, and began the study of geology and mineralogy under Silliman. Such was the energy and enthusiasm of Eaton that in a year or so he had mastered the science, and began a series of excursions, on foot, throughout New England and New York, giving short lectures on natural history all along his route. He also delivered a course of such lectures at Williams College, which aroused great interest in natural history in that institution. The inspiration of this scientific teacher attracted the attention of Governor DeWitt Clinton of New York State and, on his invitation, in 1818, Professor Eaton delivered a course of lectures before the State Legislature. The interest in natural history, created by his untiring devotion to the cause and by his numerous lectures and writings, specially by his writings and maps published after he had been appointed senior professor of science at the Rensselaer School at Troy, were destined to bring about the organization of the State Natural History Survey. He may justly be termed the father of New York State geology, for to him, above all others, the State owes its wonderful achievements in geologic work. His first important work was an *Index to the Geology of the Northern States,* written as a textbook and published in 1818. This contained a geologic section which included the region east of the Catskills and extended east to Boston. This was followed a few years later by other published sections, including New York State, but all were very crude measured by present standards and were strongly tinged by Wernerism.

During this period a new means for the publication of short geological papers and small maps was brought into being by the founding of Silliman's *Journal* in 1818 and soon papers and maps of a geologic nature began to appear in its pages as can be seen



Exhibition of the cuneiform termination of strata.
Profile Section from Jefferson Cº N.Y. to Northampton Cº Penn. 200 Miles
Explanation of the
COLOURS
SLATE Carboniferous formations No. I
Primitive. No. II Trans. No. III Lower
secondary. No. IV Upper secondary.
No. V Tertiary.
YELLOW. all the quartzose formations
BLUE. all the calcarous formations
RED. variegated sandstone support-
ing salt springs or basalt.
GREEN. lias & ferriferous rocks of a
subordinate series
GREEN SPOTS. basaltic rocks
BLUE SPOTS. superficial spots of
white shell marle, being the cal
careous formation of the 5th series.
This Colour'd map exhibits a
general view of the
ECONOMICAL GEOLOGY
of New York and part of the
adjoining States; as directed
by the honourable Stephen Van
Rensselaer. By Amos Eaton
Rensselaer School
Troy Jan. 1, 1830
Canada Line 45° N. Lat.
LAKE ONTARIO
L. ERIE
L. CHAMPLAIN
LONG ISLAND SOUND
ATLANTIC OCEAN
Erie Canal
Pennsylvania Line
Catskill Mts.
Profile Section from Niagara Falls to Sandy Hook
40° 30' N. Lat.
74° W. Lon.

by a glance at the index, those between 1822 and 1834 being small black and white etchings.

We come now to the publication of the first geologic map of New York State as a unit. This was Eaton's map published with his "Textbook" in 1830. This is a curiously interesting hand-colored map of the State. On it he divided the regular deposits according to the following Wernerian scheme: five "classes" called Primitive, Transition, Lower Secondary, Upper Secondary and Tertiary were distinguished and these in turn were each divided into three formations called "Carboniferous," "Quartzose" and "Calcareous." The colors represented on the map are six, one color, slate, representing all the "Carboniferous" formations, the Roman numerals I, II and III representing whether they belonged to the "Primitive" or "Secondary (Lower or Upper)." Other colors represented the quartzose and calcareous formations, the variegated red sandstone, one color being used for both the present Medina and the Triassic red sandstone, or as he says "sandstones supporting salt springs or basalt," the "lias or ferriferous rocks of a subordinate series" roughly corresponding to the present Salina shales, Basaltic rocks and "superficial shell marl" scattered in spots over the southern tier of counties.

Professor Eaton made a poor attempt at mapping the Adirondacks. As they appear on his map they consist of alternating bands of Primitive and Secondary Carboniferous and Calcareous rocks. He notes in the text various Adirondack rocks most of which are now known to be igneous, but says, "we infer that granite, mica slate, hornblende rock, talcose slate, granular quartz and granular limestone had all been *deposited* and become indurated before any plants or animals had been created."

In the early thirties, various influences were brought to bear upon the New York State Legislature, toward the establishment of a museum of natural history and a geological survey of the State. First of these was the work done by Professor Eaton from 1820 to 1830, which has already been noted. This work was carried on under the patronage of Hon. Stephen Van Rensselaer. In 1834 the Albany Institute[1] presented to the Legislature a memorial asking for the establishment of a State Museum, and in 1835 the New York Lyceum of Natural History (The American Institute of the City of New York) presented a similar petition or memorial.[2]

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[1] Senate Document no. 75. 1834.

[2] Assembly Document no. 374. 1835.

Induced by these expressions of public sentiment, the Legislature passed a resolution in 1835 asking the Secretary of State to report to that body a method for obtaining a natural history survey of the State, and for collecting, and preserving specimens collected, and for publishing reports. Such a report was presented to the Legislature of 1836, by Hon. John A. Dix, Secretary of State, and was adopted by the Legislature, and the Natural History Survey was organized. The scientific staff of the Survey in 1836 consisted of John Torrey, Botanist; James E. DeKay, Zoologist; Lewis C. Beck, Mineralogist; W. W. Mather, Ebenezer Emmons, Lardner Vanuxem and Timothy A. Conrad, Geologists; the four geologists each being assigned to a definite section of the State. In 1837, Conrad was made Paleontologist and James Hall who had been the year before assistant under Professor Emmons, was appointed to succeed Vanuxem, who took Conrad's place. This early survey was, as Merrill[1] says, "an organization which has left a more lasting impression upon American geology than any that has followed it or preceded it."

The reports of this early survey contained various maps, the first of which was a most interesting and quaint birdseye map of the Genesee river and vicinity, showing geological features. It was a black and white sketch map showing the river as seen from an elevated observation point. The rock geology is indicated by short notes printed along the margins and on the sketch: such as "Fucoides in sandstone," "dark argillaceous shales," "beds of gypsum Garbutts mills," "Calymene in green shales," etc. Glaciated surfaces are indicated, small sketches of fossils depicted, the horizontality of the beds exposed in portions of the gorge, and many interesting features shown. Prof. Eben N. Horsford, although his name appears only as the delineator of this map, in reality worked out by his own efforts whatever geological features are depicted thereon. Born at Moscow, N. Y., he became interested in the fossils of the region and in his excursions accumulated quite an extensive knowledge of the local geology and paleontology. He was at one time principal of the Albany Female Academy and subsequently became Rumford professor of chemistry at Harvard.

This was followed by other maps and sections in the reports of the geologists of the various districts and in the four quarto volumes published in 1842 and 1843. Of these the most import-

[1] U. S. Nat. Mus. Rep't for 1904. 1906. p. 344.

ant was that by James Hall, a Geological Map of the Middle and Western States, which has had a powerful influence on the geology of eastern United States. This hand-colored map indicates the phenomenal advance made in stratigraphy since the publication of Eaton's map of the State 12 years before, and Hall's map appears with divisions, a number of which have remained almost as set down, to the present day. In the interval between the two maps, Murchison and Sedgwick in Great Britain had carried on their stratigraphic studies clearing up or even beginning a real classification of sedimentary strata. The efforts of these men were felt in America, and New York State forged its way to the front under the leadership of James Hall, who in turn was guided by the overruling persuasion of Murchison.

Accompanying these reports and published separately was also the famous "1842" map of the State Geologists. Previous to its appearance all geologic mapping had been greatly hampered by a lack of accurate base maps on which to indicate the geological formations. Therefore the State had a special map engraved for use by the survey and this was used in the 1842 map. This was hand-colored, prepared by the four geologists, Emmons, Hall, Vanuxem and Mather. They had been obliged to create what was called the "New York system" of rocks including the strata from the Potsdam to the Carboniferous, as they were as yet unable to correlate the various strata with Murchison's Cambrian, Silurian and Devonian. The central mass of the Adirondacks was all colored as Primary.

Dr Emmons's views in regard to the Taconic system were at variance with those of other geologists and later (1844) he prepared a map on the same base as the former one, but having his Taconic system upon it. This has been called the "Emmons map." It was, however, never widely distributed. The 1842 map, as Professor Marcou says,[1] marked "a second starting point in American geology" and adds that it gave a good classification of the American paleozoic rocks due mainly to the researches of Emmons and Vanuxem, an unjust comment due to his personal dislike to Professor Hall, and giving him but scant credit for his important share in the work.

The next published maps were those of Sir Charles Lyell accompanying his North American travels. They dealt with western New York, but included one United States map, the New York

[1] U. S. Geol. Sur. Bul. 7. 1884. p. 59.

portion of which he compiled from the early Natural History reports, since he says he had not yet seen the 1842 map. County maps, black or white etchings, next began to appear in the New York Society of Agriculture Transactions but are of little importance.

In 1865 there was published by the Canadian Geological Survey in its report of progress for 1863, a Geologic Map of Canada and the Northern Portion of the United States. The Canadian portion of this map was prepared by Sir W. E. Logan while the United States portion was compiled under the authority of Prof. James Hall. It is of interest in connection with this paper because of the fact that the New York State geology indicated upon it is the first authoritative revision of the 1842 map. The map is on a scale of 125 miles to the inch and is very well colored. It was in reality a reduction from a much larger map on a scale of 25 miles to the inch which although already engraved in 1863 was not published till 1867. This larger map was published separately and not widely distributed. It is said that but three copies were sent to the United States.

Up to this time colorations of maps in this country had been done by hand, a tedious and often unsatisfactory process. In European countries, schemes for color printing had been devised and successfully carried out, as early as 1843. In America, however, the chromolithographic methods supplanted but slowly the hand coloration and although the first map printed in color appeared in 1853 in Massachusetts, no such work was carried on in New York State till 1875. The first map with printed colors in the State appears to have been the map of New York State and the Eastern States by Hall appearing in the Museum reports.

The early Museum reports, the first of which appeared in 1848, contained but few maps previous to 1884 and the maps of the period 1875 to 1885 were published mainly by the *American Journal of Science* and other private publications, by James D. Dana and others, and dealt with eastern and southeastern New York.

The maps appearing in the years 1885 and 1886 dealt also with eastern New York with the exception of a map of Ontario county by John M. Clarke, and several maps dealing with the oil region of Allegany county were the first economic maps to be published.

In the nineties the most notable feature was the earnest endeavor made to work out the relation in the Adirondack crystalline area. This work was commenced in 1895 by Kemp and a number of maps appear in that decade by Cushing, Kemp and others. Glacial

geology was also represented in the decade by H. L. Fairchild's maps on the glacial geology of western New York. Since 1900 the progress in mapping the geology has proceeded rapidly along all lines, numerous areal, economic, stratigraphic, paleogeographic and pleistocene maps all having been published. The main efforts, at present, are toward a complete geologic map of the State using the quadrangles surveyed by the United States Geological Survey as a base, and a number of such quadrangles have been published. In this way, piece by piece, like the forming of a mosaic picture, the detailed geology of the State is being worked out.

The last complete map of the State was the 1901 map by F. J. H. Merrill corrected up to date from the Hall-McGee map of 1894. This represents the results of all the geologic work done previous to that time and is a fitting map with which to compare the earlier efforts of McClure and Eaton.

We have now reached the hundredth anniversary of the geologic map of the United States and incidentally of this State, and although there is yet much to be done, the work from now on must be of detailed character and we may expect no great changes in the general map. We have reviewed the five complete maps: the McClure 1809, the Eaton 1830, the 1842 map, the Hall map of 1894 and lastly the Merrill map of 1901, and we have also noted the smaller sections mapped by counties, townships and even quadrangles.

In making up the chronological list the date given on the margin indicates the date of publication, and does not represent the date on the map or the year of which an annual report is a review, these dates where given having been inclosed in parentheses. Under the years the maps are arranged alphabetically by authors.

The author has aimed at getting together all geologic maps dealing with New York State geology. It is realized that some have probably been overlooked, but all of importance are probably included. Many maps used in textbooks and other such literature, which are evidently but copies of some maps listed here, have purposely been omitted. Maps of the United States and other large maps simply including New York State as a portion of a larger area have been listed but sparingly, only the more interesting of such having been examined. Following the chronologic list is an index by means of which, it is hoped, the maps dealing with a certain section of the State or maps by certain authors can readily be located in the chronologic list.

CHRONOLOGICAL LIST OF MAPS SHOWING GEOLOGY OF NEW YORK STATE

References made simply to museum bulletins, museum reports or geologist's reports, refer to publications of the New York State Museum. Exact titles are printed in italics.

(1) 1809 **McClure, William.** *Map of the United States of America*; colored geologically. Accompanies "Observations on the Geology of the United States" by William McClure. Am. Phil. Soc. Trans. 1809. Ser. 1, v. 6 (front). 54 x 45 cm. Scale about 1 in. to 75 m. A hand-colored map representing five divisions: Primitive, Transition, Secondary, Salt and Alluvial.

(2) 1818 ——— Colored sections across the United States. Accompanies "Observations on the Geology of the United States" by William McClure. Am. Phil. Soc. Trans. 1818. n. s. v. 1, facing p. 91. Two of these sections include New York State.

(3) 1818 ——— *Map of the United States of America*. Accompanies "Observations on the Geology of the United States" by William McClure. Am. Phil. Soc. Trans. 1818. n. s. v. 1 (front). 44 x 33 cm. Scale about 1 in. = 95 m. A hand-colored map with a number of changes since the map of 1809.

(4) 1818 **Eaton, Amos.** A geological section extending from the Catskills to Boston. Accompanies "Index to the Geology of the Northern States." ed. 1, 1818. A black and white section.

(5) 1820 **Akerly, Samuel.** Geological section from neighborhood of Sandy Hook, N. J., northward through the Highlands in New York toward the Catskill mountains. Accompanies "Essay on the Geology of the Hudson River" by S. Akerly. 1820.

(6) 1820 **Eaton, Amos.** Section from the Susquehanna river near Jericho, N. Y. to Boston, Mass. Accompanies "Index to the Geology of the Northern States," by Amos Eaton. ed. 2, 1820. A black and white section showing a lithologic classification of strata.

(7) 1822 **Barnes, D. H.** Geological section of Canaan mountain. Am. Jour. Sci. 1822. v. 5, facing p. 8. Black and white.

(8) 1822 **Barton, D. W.** A map of the Catskills. Accompanies "Notice of the Geology of the Catskills," by D. W. Barton. Am. Jour. Sci. 1822. v. 4, facing p. 277. Black and white with geological indications.

(9) 1822 **Eaton, Amos.** *Geological Profile of the Rocks from Onondaga Salt Springs, N. Y. to Williams College, Mass.* Accompanies "A Geological and Agricultural Survey of Rensselaer Co.," by Amos Eaton, 1822. Black and white. Scale 1 in. = 10 m

(10) 1824 **Dewey, Chester.** *Geological Map of the County of Berkshire, Mass., and a Small Part of the Adjoining States.* Am. Jour. Sci. 1824. v. 8, facing p. 200. A hand-colored map 20 x 30 cm, including portions of Rensselaer, Columbia and Dutchess counties.

(11) 1824 (1822) **Eaton, Amos.** *Geological Profile Extending from the Atlantic to Lake Erie.* Accompanies "A Geological and Agricultural Survey of the District Adjoining the Erie Canal," by Amos Eaton. 1824. Pt 1.

(12) 1830 ——— *Colored Map Exhibiting a General View of the Economical Geology of New York and Parts of Adjoining States.* Accompanies "A Geological Text Book," by Amos Eaton, 1830. A hand-colored map of the State. The first geological map of New York State. 31 x 38 cm.

(13) 1832 **Young, J. B. & Heron J.** *A Geological Mineralogical Map of Part of Orange Co.* Am. Jour. Sci. 1832. 21:321. Scale 1 in. = 2 m. A black etching.

(14) 1838 **Hall, James.** *Section from the Mouth of the Genesee River to Instantur, Pa.* N. Y. State Assembly Doc. 200, 2d Rep't on 4th dist. 1838. Shows in black and white a vertical section.

(15) 1838 **Horsford, E. N.** *Geology of the Genesee River.* Accompanies N. Y. State Assembly Doc. 200, 2d Rep't on 4th dist. by James Hall. 1838. Shows various rock outcrops in black and white.

(16) 1841 **Emmons, E.** *Map of the Tertiary of Essex County.* N. Y. State Assembly Doc. 150, 1841, 5th Rep't of the Geologist of the 2d dist. 1841. A black and white etching showing outcrops of rocks (Calciferous, Potsdam, gneiss etc. with Tertiary (?).

(17) 1842 **Emmons, Vanuxem, Mather & Hall.** *Geologic Map of the State of New York.* Colored geologic map published separately. 92 x 99 cm. Scale 1 in. = 12 m.

(18) 1842 **Emmons, E.** *Geological Map of Clinton County.* Geol. N. Y. pt 2. 1842. pl. 17. Primary, Calciferous, Potsdam, Chazy, Birdseye, Trenton etc.

(19) 1842 ——— *Map of Jefferson County.* Geol. N. Y. pt 2. 1842. pl. 16. A hand-colored map showing Primary, Lorraine, Trenton, Potsdam, Calciferous etc.

(20) 1842 ——— Sections in the 2d geological district. Geol. N. Y. pt. 2. 1842. pl. 6-12. Colored geological sections.

(21) 1842 **Percival, James G.** A map of Connecticut including a portion of New York. Scale 1 in.= 5 m. Accompanies "Report on the Geology of Connecticut." 1842.

(22) 1843 **Cozzens, Issacher, jr.** *A Geological Map of New York or Manhattan Island.* Accompanies "A Geological History of Manhattan or New York Island" by I. Cozzens, 1843 (front). Shows the geology in colors and is accompanied by two sections.

(23) 1843 **Hall, James.** *Geological Map of the Middle and Western States.* Geol. N. Y. pt 4. 1843. Follows p. 685. Scale 1 in.= 30 m. A large hand-colored geological map accompanied by a section sheet.

(24) 1843 ——— Sections in the 4th geological district. Geol. N. Y. pt 4. 1843. pl. 2-13. Colored geological sections.

(25) 1843 **Mather, W. W.** *Geological and Mineralogical Map of Part of Orange County.* Geol. N. Y. pt 1. 1843. pl. 41. Black and white.

(26) 1843 ——— Geological sections in the 1st geological district. Geol. N. Y. pt 1. Various plates.

(27) 1843 ——— North end of New York Island and sketch of Sterling Iron Mine. Geol. N. Y. pt 1. 1843. pl. 30. Colored geological maps.

(28) 1843 ——— Map of the Hudson river district near Rhinebeck, Germantown etc. Geol. N. Y. pt 1. 1843. pl. 29. A colored sketch map.

(29) 1843 ——— Map of area from Barnegat to Fishkill-on-the-Hudson. Geol. N. Y. pt 1. 1843. pl. 28. A colored geologic sketch map with two sections.

(30) 1843 ——— Geological sections on Long Island. Geol. N. Y. pt 1. 1843. pl. 4.

(31) 1843 ——— Geological sections of New York Island, and Lansingburg, Rensselaer co. Geol. N. Y. pt 1. 1843. pl. 3.

(32) 1843 ——— Oyster Pond Point, Sands Point, etc. Geol. N. Y. pt 1. 1843. pl. 2. Small sketches of the geology and topography.

(33) 1843 ——— Map of Rockland county, Westchester county, Long Island and Staten Island and New York Island. Geol. N. Y. pt 1. 1843. pl. 1. A large colored geologic map.

(34) 1844 **Emmons, E.** *Agricultural and Geological Map of the State of New York.* Same as "1842" map of the four geologists but contains the Taconic system.

(35) 1845 **Lyell,** *Sir* **Charles.** *Map of the Niagara District.* Accompanies "Travels in North America," by Sir Charles Lyell. 1845. v. 1, facing p. 30. A hand-colored map showing the strata Medina to Helderberg.

(36) 1845 ——— *Birdseye View of the Falls of Niagara and Adjacent Country Colored Geologically.* Accompanies "Travels in North America," by Sir Charles Lyell. 1845. v. 1 (front). Color printing used on this map. A panoramic view of the country from Lake Erie to Lewiston. This is the first example of color printing found on any geologic map in the United States, and was done in London.

(37) 1845 ——— *Geological Map of the United States and Canada.* Accompanies "Travels in North America," by Sir Charles Lyell. 1845. v. 2 (front). A very nicely hand-colored map. The New York portion was drawn from data obtained from the 1842 and 1843 reports of the Natural History Survey, as he had not seen the large map.

(38) 1850 **Fitch, Asa.** Geological sections across Washington county. N. Y. Agric. Soc. Trans. (1849). 1850. v. 9, facing p. 820.

(39) 1850 ——— Geological map of Washington county. N. Y. Agric. Soc. Trans. (1849). 1850. v. 9, facing p. 907. A black and white etching showing surficial deposits.

(40) 1853 **Marcou, Jules.** *Geological Map of the United States and British Provinces of North America.* Published with an explanatory text 1853. Scale 1 in. = 90 m. A hand-colored map showing the geology of New York State divided into Devonic, Upper and Lower Siluric, Igneous and metamorphic, copper trap, New Red sandstone, Tertiary and Quaternary.

(41) 1860 **Geddes, George.** *Geological and Topographical Map of Onondaga County.* N. Y. Agric. Soc. Trans. (1859). 1860. v. 19, facing p. 218. Scale 1 in. = $1\frac{3}{4}$ m. A large hand-colored map showing the areal geology from the Clinton to the Genesee formations accompanied by one structural section.

(42) 1862 **Denniston, Goldsmith.** Map of Steuben county. N. Y. Agric. Soc. Trans. (1861). 1862. v. 21, facing p. 548. 43.5 x 42.5 cm.

(43) 1863 ——— Map of Orange county. N. Y. Agric. Soc. Trans. (1862). 1863. v. 22, facing p. 136. The soils and rock outcrops are indicated by writing. 59 x 47.5 cm.

(44) 1865 **Credner, H.** *Geologische skizze von New York.* Accompanies "Geognostistiche skizze der umgegend von New York." H. Credner, in Zeit. Deut. Geol. Gesel. 1863. v. 17, Taf. 13.

(45) 1865 **Logan,** *Sir* **W. E. (& Hall, James).** *Geological Map of Canada.* Geological Survey of Canada. Atlas accompanying report of progress from commencement to 1863. 1865. Scale 1 in. = 125 m. A colored geologic map, including geology of a part of the United States by Hall. The New York portion was the first authoritative revision of the 1842 map.

(46) 1866 ——— *Geological Map of Canada.* Geological Survey of Canada, published separately. Scale 1 in. = 25 m. This map is the same as the one published in 1865 but on a larger scale. The 1865 map was in reality a reduction from this map.

(47) 1875 **Carll, J. F.** Map covering a portion of western New York. 2d Geol. Sur. of Penn. Rep't 1. Report of progress in Venango co. 1875. p. 57–108.

(48) 1875 **Hall, James.** Map of eastern United States. Mus. Rep't 27 (1873). 1875. 70 x 50 cm. This is the first geologic map dealing with New York State which was colored by color printing in this country. It shows the relations of the Niagara and Lower Helderberg formations.

(49) 1880 **Dana, J. D.** *Limestone Areas of Westchester County.* Am. Jour. Sci. 1880. ser. 3, v. 20, pl. 5, facing p. 359. Scale 1 in. = 3 m. A plain map showing limestone areas in blue.

(50) 1880 ——— *Limestone areas of Dutchess, Westchester and Putnam Counties, etc.* Am. Jour. Sci. 1880. ser. 3, v. 20, facing p. 450. A black and white map showing limestone, archaean and trap formations. Scale 1 in. = 10 m.

(51) 1880 ——— *Part of Western Cortlandt.* (Westchester co.) Am. Jour. Sci. 1880. ser. 3. 20: 194. A black and white geologic map.

(52) 1880 ——— *Geological Map of Part of New York and New Jersey from Prof. G. H. Cook's map of New Jersey.* Am. Jour. Sci. 1880. ser. 3, v. 20, pl. 9. A black and white geologic map of portions of Orange and Rockland counties.

(53) 1881 **Britton, N. L.** *A Geological Map of Richmond County.* N. Y. Acad. Sci. Ann. 1882. v. 2, pl. 15, facing p. 161. Also in Columbia School of Mines Quart. 1881. v. 2, pl. 1. Scale 1 in. = 2 m. 18 x 21 cm.

(54) 1881 **Dana, J. D.** *Geological Map of Southern Westchester County and Northern New York Island.* Am. Jour. Sci. 1881. ser. 3, v. 21, pl. 19. Scale 1 in. = 2 m. A plain map with limestone areas plotted in blue. 23.5 x 32.5 cm.

(55) 1881 ——— *Map of Parts of New York and New Jersey.* Am. Jour. Sci. 1881. ser. 3. 22: 106. A black and white geologic map of portions of Orange and Rockland counties.

(56) 1881 ——— Map of Stony Point (Rockland co.). Am. Jour. Sci. 1881. ser. 3. 22: 112. A small black and white map, the Triassic, limestone and conglomerate being indicated by writing.

(57) 1881 ——— Map of Part of Western Cortlandt showing Peekskill, Verplanck, Tompkins Cove and Cruger Limestone Areas by Horizontal Linings. Am. Jour. Sci. 1881. ser. 3. 22: 107. Black and white etching.

(58) 1882 **Hall, James.** New York State. In report of Public Service of the State of New York. Scale 1 in. = 38 m. A black and white map.

(59) 1882 **Johnson,** *Dr* **Lawrence.** *A Geological Map Designed to Illustrate a Paper on the Parallel Drift of Hills of Western New York.* Am. Jour. Sci. 1882. v. 2, pl. 18, facing p. 288. A black and white map with formations indicated by name and dotted boundaries. The first map dealing with glacial geology.

(60) 1884 **Davis, W. M.** A map showing portion of Greene county. Appalachia 1884. 3: 20–33. Accompanies paper by W. M. Davis on "Little Mountains East of the Catskills." Scale 1 in. = $\frac{3}{5}$ m. A black and white geological map of region near Catskill, with numerous sections.

(61) 1884 ——— Map of Greene county. Harvard Coll. Mus. Comp. Zool. Bul. 1884. 7: 311–29. Accompanies paper on Folded Helderberg limestones east of the Catskills.

(62) 1884 **Wright, B. H.** Map of Yates county. Mus. Rep't 35 (1881). 1884, between pl. 15 and 16. A colored geological map showing formations Marcellus to Chemung and salt, gas and stone quarries. 24 x 21 cm.

(63) 1885 **Clarke, J. M.** *A Geological Map of Ontario county.* Geol. Rep't 4 (1884). 1885. Facing p. 8. A colored map showing formations Salina to Chemung and Quaternary. Scale 1 in. = $2\frac{1}{2}$ m. 36 x 33.5 cm.

(64) 1885 **Dana, J. D.** *Geologic Map of the Taconic Region.* Am. Jour. Sci. 1885. ser. 3. v. 29, facing p. 222. Includes northeast Ancram and Copake townships in Dutchess and Columbia counties.

(65) 1885 **Ford, S. W.** Vicinity of Schodack Landing. Am. Jour. Sci. 1885. ser. 3. 29: 17. A small black and white geologic map showing the Lorraine and Lower Potsdam.

(66) 1885 **Hall, C. E.** *Geologic Map of Essex county.* Geol. Rep't 4 (1884). 1885. Facing p. 23. 48 x 40.5 cm.

(67) 1885 **Wendt, A. F.** *Map of Putnam County.* Am. Inst. Min. Eng. 1885. v. 13, facing p. 488. Gives simply mine locations.

(68) 1886 **Beecher, C. E. & Hall, C. E.** Map showing results of field work in Mohawk valley. Geol. Rep't 5 (1885). 1886. Facing p. 8. Scale 1 in. = 6 m. A map of partial geology in colors; Little Falls to Amsterdam.

(69) 1886 **Hitchcock, Charles H.** Map showing distribution of iron ores in New York State. 10th Census Rep't. 1886. v. 15. Scale 1 in. = 25 m.

(70) 1886 **Smock, J. C.** *Map of Archaean Areas of the Highlands, east of the Hudson River.* Mus. Rep't 39 (1885). 1886. Facing p. 184. Scale 1 in. = $6\frac{3}{10}$ m. A black and white map showing Archaean areas east of the Hudson river. 11 x 18.5 cm.

(71) 1887 **Ashburner, C. A. & Carll, J. F.** Map of the oil regions of Pennsylvania and New York. Am. Inst. Min. Eng. 1887. 15: 540. Scale 1 in. = 50 m. A black and white map showing developed oil pools.

(72) 1887 **Dana, J. D.** *Geologic Map of Middle and Northern Berkshire.* Am. Jour. Sci. 1887. ser. 3. p. 432.

(73) 1887 **Hitchcock, C. H.** *Geological Map of the United States and Parts of Canada.* Am. Inst. Min. Eng. Trans. 1887. v. 15, facing p. 486. A colored geological map, scale 1 in. = 115 m.

(74) 1887 **Williams, S. G.** Map showing geographic distribution of Tully limestone in central New York. Geol. Rep't 6 (1886). 1887. Facing p. 28. Scale 1 in. = 8 m. Tully limestone mapped in blue on plain map. 37.5 x 19 cm.

(75) 1888 **Ashburner, C. A.** *Map of the Allegany Oil and Gas District.* Am. Inst. Min. Eng. 1888. 16: 958. Scale 1 in. = $1\frac{3}{5}$ m. A black and white map showing the area of oil territory and the pipe lines.

(76) 1888 ——— *Sketch Geological Map of Portions of New York and Pennsylvania.* Am. Inst. Min. Eng. 1888. v. 16, pl. 1, facing p. 958. Scale 1 in. = 25 m. A colored geologic map showing formations Medina to Carboniferous.

(77) 1888 **Kemp, J. F.** *Geologic Map of the Vicinity of Rosetown.* Am. Jour. Sci. 1888. ser. 3. 36: 248.

(78) 1888 **Martin, D. S.** *Geological Map of New York City.* Accompanied by pamphlet, 1888. Scale 1 in. = 2 m.

(79) 1888 **Walcott, C. D.** *Geologic Map of Part of Eastern New York, Western Vermont, Western Massachusetts and Northwestern Connecticut.* Am. Jour. Sci. 1888. ser. 3. 35: 346, pl. 3. Shows the geology of the region east of the Hudson river in colors. Scale 1 in. = 10 m.

(80) 1889 **Smock, J. C.** Map showing location of iron ore mines in New York State. Mus. Bul. 7. 1889. Facing title-page. Scale 1 in. = 16 m.

(81) 1890 **Darton, N. H.** *Geologic Map of Northern New Jersey and Adjacent Portions of New York and Pennsylvania.* U. S. Geol. Sur. Bul. 67. 1890 (front); *also* U. S. Geol. Sur. Bul. 85. 1892. p. 24–25. Scale 1 in. = 8½ m. A colored map. 22 x 22 cm.

(82) 1890 ——— Map of Rockland county. U. S. Geol. Sur. Bul. 67. 1890. p. 40. Scale 1 in. = 1½ m. A black and white geologic map showing Triassic, Cambrian, Archaean etc.

(83) 1890 **Smock, J. C.** Map of New York State (economic). Mus. Bul. 10. 1890. Facing p. 396. Scale 1 in. = 15 m. A plain map on which the location of all building stone quarries is indicated in red. 58 x 60 cm.

(84) 1892 **Lincoln, D. F.** Map of Finger Lake region. Am. Jour. Sci. 1892. ser. 3. 44: 291. A black and white map showing the glacial geology and the Corniferous and Tully limestone boundaries dotted in.

(85) 1892 **Russell, I. C.** *Newark-Virginia and Other Newark Areas.* U. S. Geol. Sur. Bul. 85. 1892. p. 20–21. Scale 1 in. = 35 m. A colored map showing the Newark traps, etc. in southeastern New York.

(86) 1892 **Van Hise, C. R. (after McGee and Hitchcock).** *Geological Map of the Northeastern States.* U. S. Geol. Sur. Bul. 86. 1892. Facing p. 348. New York State colored in two colors representing Post-Algonkian and unclassified Precambric.

(87) 1893 **Dale, T. N.** *Region between the Taconic Range and the Hudson Valley.* U. S. Geol. Sur. 13th An. Rep't pt 2. 1893. pl. 97. Scale 1 in. = 5 m. The geology of Rensselaer and Columbia counties shown on a colored map.

(88) 1893 **Hobbs, W. H.** A geological map of the Mt Washington district. Jour. Geol. 1893. v. 1, facing p. 726. Shows the geology of the eastern part of Columbia and Dutchess counties, in black and white.

(89) 1893 **Kemp, J. F. & Marsters, V. F.** *General Map of Lake Champlain Region showing Distribution of Dikes.* U. S. Geol. Sur. Bul. 107. 1893. pl. I. Dikes are plotted on plain map. 20 x 35 cm.

(90) 1893 ——— *Sketch Map of Dikes at Split Rock and Vicinity.* U. S. Geol. Sur. Bul. 107. 1893. p. 40. A black and white geological map showing distribution of dikes.

(91) 1893 ——— *Sketch Map of Dikes on Mill Brook near Port Henry.* U. S. Geol. Sur. Bul. 107. 1893. p. 40. Scale 1 in. = 100 ft. A small black and white map showing dikes.

[(92) 1893 ——— *Sketch Map of Dikes on Trembleau Point near Port Kent.* U. S. Geol. Sur. Bul. 107. 1893. p. 45.

(93) 1893 **Merrill, F. J. H.** Map of the salt region of Genesee, Livingston and Wyoming counties. Mus. Bul. 11. 1893 (cover). Scale 1 in. = 3 m. On plain map the underground contours of the salt beds are given and the location of the wells. 52 x 32.5 cm.

[(94) 1893 ——— Map of New York State showing distribution of the Salina group and salt and gypsum deposits. Mus. Bul. 11. 1893 (cover). Scale 1 in. = 16 m. 38 x 55 cm.

(95) 1894 **Baldwin, S. P.** *Lake Champlain and its Pleistocene Area.* Am. Geol. 1894. v. 13, facing p. 170. A black and white map showing sand deltas, eskers etc.

(96) 1894 **Clarke, J. M.** Map showing location of salt wells and mines in western New York. Geol. Rep't 13 (1893). 1894. Facing p. 22; *also* Mus. Rep't 47 (1893). 1894. Facing p. 215.

(97) 1894 ——— Map showing area of Onondaga salt group. Geol. Rep't 13 (1893). 1894. Facing p. 14; *also* Mus. Rep't 47 (1893). 1894. Facing p. 208. A plain map with the Onondaga salt group plotted in blue. 37 x 14.5 cm.

(98) 1894 **Cushing, H. P.** Map of Chazy township, Clinton county. Geol. Soc. Am. Bul. 1894. v. 6, facing p. 284. Accompanies paper on Faults of Chazy township. Scale 1 in. = $\frac{3}{4}$ m. A black and white geologic map with sections.

(99) 1894 ——— Map of a portion of Clinton county. Geol. Rep't 13 (1893). 1894. Facing p. 480; *also* Mus. Rep't 47 (1893). 1894. Facing p. 674. Scale 1 in. = 2 m. A black and white geologic map.

(100) 1894 ——— Map of parts of Clinton county. Geol. Rep't 13 (1893). 1894. Facing p. 478; *also* Mus. Rep't 47 (1893). 1894. Facing p. 672. Scale 1 in. = 2 m. A black and white geologic map.

(100a) 1894 **Darton, N. H.** Map of southwestern part of Albany county. Geol. Rep't 13 (1893). 1894. Facing p. 254; *also* Mus. Rep't 47 (1893). 1894. Facing p. 448. Scale 1 in. = $1\frac{3}{10}$ m. A black and white stereogram.

(101) 1894 ——— *Region around Saugerties.* Geol. Rep't 13 (1893). 1894. Facing p. 317; *also* Mus. Rep't 47 (1893). 1894. Facing p. 504. Scale 1 in. = 1 m. A black and white stereogramic map showing formations Hudson River series to Hamilton.

(102) 1894 ——— *Geologic Map of Kingston Region,* Ulster co. Geol. Rep't 13 (1893). 1894. Facing p. 318; *also* Mus. Rep't 47 (1893). 1894. Facing p. 512. Scale 1 in. = 3000 ft. A black and white geologic map and sections.

(103) 1894 ——— *Stereogram of Shawangunk Mountain in Ulster county.* Geol. Rep't 13 (1893). 1894. Facing p. 346; *also* Mus. Rep't 47 (1893). 1894. Facing p. 540. Scale 1 in. = 3 m. A black and white stereogram showing formations Hudson River to Hamilton.

(104) 1894 ——— Rosendale cement region, Ulster county. Geol. Rep't 13 (1893). 1894. Facing p. 326; *also* Mus. Rep't 47 (1893). 1894. Facing p. 520. Scale 1 in. = 1 m. A black and white stereogramic map.

(105) 1894 **Davis, W. M.** Map of southern part of the Kingston region. Geol. Rep't 13 (1893). 1894. Facing p. 329; *also* Mus. Rep't 47 (1893). 1894. Facing p. 523. Scale 1 in. = ½ m. Black and white map showing Cauda galli grit to Hudson River series, with sections.

(106) 1894 **Hall, James.** *Preliminary Geologic Map of New York.* Published separately. This map was compiled by W. J. McGee and is known as the McGee map.

(107) 1894 ——— A map showing salt-producing districts of western New York. Geol. Rep't 13 (1893). 1894. Facing p. 22; *also* Mus. Rep't 47 (1893). 1894. Facing p. 215. On plain map the districts are marked in color. 34.5 x 21.5 cm.

(108) 1894 **Kemp, J. F.** Map of St Armand township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 470; *also* Mus. Rep't 47 (1893). 1894. Facing p. 664. Scale 1 in. = 2 m. A black and white geologic map.

(109) 1894 ——— Map of North Elba township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 470; *also* Mus. Rep't 47 (1893). 1894. Facing p. 664. Scale 1 in. = 3½ m. A black and white geologic map.

(110) 1894 ——— Map of Keene township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 68; *also* Mus. Rep't 47 (1893). 1894. Facing p. 662. Scale 1 in. = 3½ m. A black and white geologic map.

(111) 1894 ——— Map of Lewis township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 466; *also* Mus. Rep't 47 (1893). 1894. Facing p. 660. Scale 1 in. = 3½ m. A black and white geologic map.

(112) 1894 ——— Map of Elizabethtown township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 466; *also* Mus. Rep't 47 (1893). 1894. Facing p. 660. Scale 1 in. = 3½ m. A black and white geologic map.

(113) 1894 ——— Map of Crown Point township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 456; *also* Mus. Rep't 47 (1893). 1894. Facing p. 650. Scale 1 in. = 2¾ m. A black and white geologic map.

(114) 1894 ——— Map of Essex township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 460; *also* Mus. Rep't 47 (1893). 1894. Facing p. 654. Scale 1 in. = 3 m. A black and white geologic map.

(115) 1894 ——— Map of Chesterfield township, Essex county. Geol. Rep't 13 (1893). 1894. Facing p. 462; *also* Mus. Rep't 47 (1893). 1894. Facing p. 656. Scale 1 in. = 3½ m. A black and white geologic map.

(116) 1894 ——— A map of Willsborough township, Essex county Geol. Rep't 13 (1893). 1894. Facing p. 462; *also* Mus Rep't 47 (1893). 1894. Facing p. 656. A black and white geologic map.

(117) 1894 **Merrill, F. J. H.** *Economic and Geologic Map of New York State.* Accompanies "New York at the World's Columbian Exposition," the report of the Board of Managers of New York's exhibit, 1894. Scale 1 in. = 14 m. A complete colored geologic map of the State, also giving the location of all economic deposits. 59 x 67 cm.

(118) 1894 **Smyth, C. H. jr.** Map of parts of Jefferson and St Lawrence counties. Geol. Rep't 13 (1893). 1894. Facing p. 493; *also* Mus. Rep't 47 (1893). 1894. Facing p. 686. A black and white geologic map.

(119) 1894 **White, T. G.** *Enlarged Map of Shores of Willsboro Bay and Willsboro Point, showing Distribution of Dikes.* N. Y. Acad. Sci. Trans. 1894. v. 13, pl. VII. Scale 1 in. = 4500 ft. Shows dikes and other geologic features.

(120) 1894 ——— Geologic map of Essex and Willsboro townships, Essex county. N. Y. Acad. Sci. Trans. 1894. v. 13, pl. VI. Scale 1 in. = 1½ m.

(121) 1895 **Darton, N. H.** Preliminary geologic map of the Mohawk valley region. Geol. Rep't 14 (1894). 1895. Facing p. 33; *also* Mus. Rep't 48 (1894). 1895. v. 2, facing p. 33. Scale 1 in. = 7 m.

(122) 1895 ——— *Sketch Map of Region North of Mayfield.* Geol. Rep't 14 (1894). 1895. p. 46; *also* Mus. Rep't 48 (1894). 1895. 2: 46. Scale 1 in. = ½ m. A black and white geologic map.

(123) 1895 **Fairchild, H. L.** *Salient Features of the Glacial Geology of Rochester, N. Y.* Am. Geol. 1895. v. 16, facing p. 40. Scale 1 in. = 1⅞ m. Shows area of various glacial deposits.

(124) 1895 **Kemp, J. F.** *Geologic Map of Moriah and Westport Townships, Essex county.* Mus. Bul. 14. 1895. Following p. 355; *also* Mus. Rep't 48, v. 1, facing p. 356. Scale 1 in. = 1 m. A black and white geologic map on topographic base. 38 x 44 cm.

(125) 1895 **Merrill, F. J. H.** *Geological Map of a Part of Southeastern New York.* Mus. Bul. 15. 1895 (cover); *also* Mus. Rep't 48 (1894). 1895. v. 1, after index to Bul. 15. Scale 1 in. = 4 m. A colored geologic map, 23 x 35 cm.

(126) 1895 ——— *Economic and Geologic Map of New York State.* ed. 2 of no. 117; Bul. 15. 1895 (cover); *also* Mus. Rep't 48 (1894). 1895. v. 1, facing p. 365.

(127) 1895 **Ries, H.** *Map of New York State Showing Location of Clay Deposits and Manufactories.* Mus. Bul. 12. 1895. (in cover); *also* Mus. Rep't 48 (1894). 1895. v. 1, facing p. 262. Scale 1 in. = 14 m. 56 x 67 cm.

(128) 1896 **Fairchild, H. L.** *Map of Victor Kame Area.* Jour. Geol. 1896. v. 4, facing p. 139. Scale 1 in. = 1⅗ m. Shows various glacial deposits near Victor, Ontario co.

(129) 1896 ——— *Map of Mendon Kame Area.* Jour. Geol. 1896. v. 4, facing p. 145. Scale 1 in. = $1\frac{1}{3}$ m. Shows various glacial deposits around Mendon, Monroe co.

(130) 1896 ——— *Map of Junius Kame Area.* Jour. Geol. 1896. v. 4, facing p. 151. Scale 1 in. = $1\frac{3}{5}$ m. Shows various glacial deposits around Junius, Seneca co.

(131) 1896 ——— *General Map of the Irondequoit-Sodus District.* Jour. Geol. 1896. v. 4, facing p. 131. Scale 1 in. = 15 m. Shows location in black and white of four kame areas.

(132) 1896 **Ries, H.** *Map of Augen-gneiss Area.* Bedford. Am. Geol. 1896. v. 18, facing p. 261. Scale 1 in. = 1 m. Shows extent of augen-gneiss, diorite, dikes and pegmatite veins around Bedford.

(133) 1897 **Bishop, I. P.** *Economic and Geologic Map of Erie county.* Geol. Rep't 15 (1895). 1897. Facing p. 392; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 392. Scale 1 in. = 4 m. On plain map shows gas territory, wells, quarries, cement and brick factories. 21 x 32 cm.

(134) 1897 **Clarke, J. M.** *Geologic Map Showing the Distribution of the Portage Group, etc.* Geol. Rep't 15 (1895). 1897. p. 60; *also* Mus. Rep't 49 (1895). 1898. pt 2, p. 60. Scale 1 in. = 5 m. A colored geologic map of a portion of western New York.

(135) 1897 ——— *Geologic Map of a Part of Chenango and Cortland Counties.* Geol. Rep't 15 (1895). 1897. Facing p. 42; *also* Mus. Rep't 49 (1895). 1898. pt 2, p. 42. Scale 1 in. = 5 m. A colored geologic map.

(136) 1897 **Cushing, H. P.** *Map of Clinton county.* Geol. Rep't 15 (1895). 1897. Facing p. 503; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 503. Scale 1 in. = $5\frac{1}{2}$ m. Shows on a black and white map the Precambrian boundary.

(137) 1897 ——— Map of Altona township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 563; *also* Mus. Rep't 49 (1895). 1898. 2: 563. Scale 1 in. = $2\frac{3}{5}$ m. A black and white geologic map.

(138) 1897 ——— Map of Chazy township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 567; *also* Mus. Rep't 49 (1895). 1898. 2: 567. Scale 1 in. = 2 m. A black and white geologic map.

(139) 1897 ——— Map of Champlain township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 572; *also* Mus. Rep't 49 (1895). 1898. 2: 572. Scale 1 in. = 2 m. A black and white geologic map.

(140) 1897 ——— Map of Beekmantown township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 560; *also* Mus. Rep't 49 (1895). 1898. 2: 560. Scale 1 in. = 3 m. A black and white geologic map.

(141) 1897 ——— Map of Plattsburg and Schuyler Falls townships, Clinton county. Geol. Rep't 15 (1895). 1897. p. 553; *also* Mus. Rep't 49 (1895). 1898. 2: 553. Scale 1 in. = 3 m. A black and white geologic map.

(142) 1897 ——— Map of Peru township, Clinton county. Geol. Rep't 15 (1895). 1897; *also* Mus. Rep't 49 (1895). 1898. 2: 550. Scale 1 in. = 3 m. A black and white geologic map.

(143) 1897 ——— Map of Ausable township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 546; *also* Mus. Rep't 49 (1895). 1898. 2: 546. Scale 1 in. = 3 m. A black and white geologic map.

(144) 1897 ——— Map of Black Brook, Clinton county. Geol. Rep't 15 (1895). 1897. p. 542; *also* Mus. Rep't 49 (1895). 1898. 2: 542. Scale 1 in. = 3 m. A black and white geologic map.

(145) 1897 ——— Map of Saranac township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 539; *also* Mus. Rep't 49 (1895). 1898. 2: 539. Scale 1 in. = 3 m. A black and white geologic map.

(146) 1897 ——— Map of Dannemora township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 536; *also* Mus. Rep't 49 (1895). 1898. 2: 536. Scale 1 in. = 3 m. A black and white geologic map.

(147) 1897 ——— Map of Ellenburg township, Clinton county. Geol. Rep't 15 (1895). 1897. p. 533; *also* Mus. Rep't 49 (1895). 1898. 2: 533. Scale 1 in. = 3 m. A black and white geologic map.

(148) 1897 **Darton, N. H. & Hall, J.** *Preliminary Geologic Map of Albany county.* Geol. Rep't 15 (1895). 1897. v. 1, facing p. 738; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 738. Scale 1 in. = 1 m. A colored geologic map on topographic base. 74.5 x 78 cm.

(149) 1897 **Fairchild, H. L.** Maps accompanying paper on Lake Warren shore lines in western New York and the Geneva beach. Geol. Soc. Am. Bul. 1897. v. 8, pl. 30.

(150) 1897 ——— *Pleistocene Geology of Western New York.* Geol. Mag. 1897. v. 4, facing p. 529. Scale 1 in. = 25 m. A black and white map showing glacial deposits.

(151) 1897 **Kemp, J. F.** *Geologic Map of Newcomb Township*, Essex county. Geol. Rep't 15 (1895). 1897. p. 604; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 604. Scale 1 in.= 2½ m. A black and white geologic map.

(152) 1897 ——— *Geologic Map of Minerva Township*, Essex county. Geol. Rep't 15 (1895). 1897. p. 602; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 602. Scale 1 in. = 2 m. A black and white geologic map.

(153) 1897 ——— *Geologic Map of Ticonderoga Township*, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 600; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 600. Scale 1 in. = 1⅝ m. A black and white geologic map.

(154) 1897 ——— Map of Schroon township, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 592; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 592. Scale 1 in. = 1⅝ m. A black and white geologic map.

(155) 1897 ——— Map of North Hudson township, Essex county. Geol Rep't 15 (1895). 1897. Facing p. 590; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 590. Scale 1 in. = 1¼ m. A black and white geologic map.

(156) 1897 ——— Map of St Armand township, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 588; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 588. Scale 1 in. = 1½ m. A black and white geologic map.

(157) 1897 ——— Map of Wilmington township, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 586; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 586. Scale 1 in. = 2 m. A black and white geologic map.

(158) 1897 ——— Map of Jay township, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 582; *also* Mus. Rep't 49 (1895). 1898. v. 2, facing p. 582. Scale 1 in. = 1¾ m. A black and white geologic map.

(159) 1897 ——— Map of Chesterfield township, Essex county. Geol. Rep't 15 (1895). 1897. Facing p. 580; *also* Mus. Rep't 19 (1895). 1898. v. 2, facing p. 580. Scale 1 in. = 1¾ m. A black and white geologic map.

(160) 1897 **Luther, D. D.** *Geological Map of Onondaga County.* Geol. Rep't 15 (1895). 1897. Facing p. 302; *also* Mus. Rep't 49 (1895). 1898. pt 2, facing p. 302. Scale 1 in. = 1 m. A colored geologic map. 34 x 38 cm.

(161) 1897 ——— Map of Naples township, Ontario county. Geol. Rep't 15 (1895). 1897. p. 236; *also* Mus. Rep't 49 (1895). 1898. 2 : 236. A colored geologic map, topography in shading. 16.5 x 17 cm.

(162) 1897 **Merrill, F. J. H.** Map of New York State showing location of stone quarries. Mus. Bul. 17. 1897 (in cover); also Mus. Rep't 50 (1896). 1898. v. 1. Scale 1 in. = 12 m. Shows location of building stone and road metal quarries. 68 x 92 cm.

(163) 1897 ——— *Map of New York State Showing Distribution of Rocks Useful for Road Material.* Mus. Bul. 17. 1897 (in cover); *also* Mus. Rep't 50 (1896). 1898. v. 1. Scale 1 in. = 24 m. 34 x 44 cm.

(164) 1897 **Prosser, C. S.** Map of Central New York showing distribution of the Hamilton and Chemung series. Geol. Rep't 15 (1895). 1897. Facing p. 87; *also* Mus. Rep't 49 (1895). 1898. 2 : 87. Scale 1 in. = 5 m. A colored geologic map.

(165) 1897 **Ries, H.** Map showing the mines and quarries of Orange county. Geol. Rep't 15 (1895). 1897. p. 475; *also* Mus. Rep't 49 (1895). 1898. 2 : 475. Scale 1 in. = 4 m. A plain map indicating the location of the mines and quarries.

(166) 1897 ——— Map of a portion of Orange county. Geol. Rep't 15 (1895). 1897. p. 415; *also* Mus. Rep't 49 (1895). 1898. pt 2, p. 415. Scale 1 in. = 1 m. A black and white geologic map.

(167) 1897 ——— *Geologic Map of Orange County.* Geol. Rep't 15 (1895). 1897. Facing p. 395; *also* Mus. Rep't 49 (1895). 1898. pt 2, p. 395. Scale 1 in. = about $2\frac{1}{2}$ m. A colored geologic map. 34 x 44 cm.

(168) 1897 ——— Map of Warwick township, Orange county. Geol. Rep't 15 (1895). 1898. p. 408; *also* Mus. Rep't 49 (1895). 1898. pt 2, p. 408. Scale 1 in. = 1 m. A black and white geologic map.

(169) 1897 ——— A map of Bull Hill, Orange county. Geol. Rep't 15 (1895). 1897. p. 420; *also* Mus. Rep't 49 (1895). 1898. 2:420. A black and white geologic map.

(170) 1897 ——— Map of the region west of Cornwall, Orange county. Geol. Rep't 15 (1895). 1897. p. 427; *also* Mus. Rep't 49 (1895). 1898. 2:427.

(171) 1897 ——— Map of Chester township, Orange county. Geol. Rep't 15 (1895). 1897. p. 428; *also* Mus. Rep't 49 (1895). 1898. 2 : 428. Scale 1 in. = 1 m. A black and white geologic map.

(172) 1897 ——— Map of Deer Park township, Orange county. Geol. Rep't 15 (1895). 1897. p. 470; *also* Mus. Rep't 49 (1895). 1898. 2 : 470. Scale 1 in. = 1 m. A black and white geologic map.

(173) 1897 ——— Map of Hamptonburg township, Orange county. Geol. Rep't 15 (1895). 1897. p. 472; *also* Mus. Rep't 49 (1895). 1898. 2 : 472. Scale 1 in. = $\frac{2}{3}$ m. A black and white geologic map.

(174) 1897 **Ruedemann, R.** Map accompanying paper on evidence of current action in the Ordovician of New York. Am. Geol. 1897. v. 19, pl. 22.

(175) 1898 **Fairchild, H. L.** *Map Showing Glacial Lake Geology of Western New York.* Geol. Soc. Am. Bul. 1898. v. 10, pl. 3. A black and white map showing distribution of kames, drumlins etc.

(176) 1898 **Kemp, J. F.** Map of the Lake Placid region. Mus. Bul. 21. 1898. (cover); *also* Mus. Rep't 52 (1898). 1900. Scale 1 in. = 1 m. Colored geologic map on topographic base, including Lake Placid and region to the east. 33 x 34 cm.

(177) 1898 **Mer ill, F. J. H.** A relief and geologic map of New York State. Mus. Bul. 19. 1898 (cover); *also* Mus. Rep't 51 (1897). 1899. v. 1, facing p. 102. Scale 1 in. = 24 m. On a relief map, the extent of the geologic systems is shown in colors. 33 x 43 cm.

(178) 1898 ——— Map of Davenport's neck, New Rochelle. Mus. Rep't 50 (1896). 1898. v. 1, pl. VI. Scale 1 in. = 1250 ft. Shows outcrops of serpentine and Ordovician schist.

(179) 1898 **Quereau, E. C.** Jamesville lake (glacial). Geol. Soc. Am. Bul. 1898. v. 9, pl. 12.

(180) 1899 **Bishop, I. P.** Map of portion of Cattaraugus county. Geol. Rep't 17 (1897). 1899. Facing p. 62; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 62. Scale 1 in. = $1\frac{3}{5}$ m. The oil and gas fields plotted in black and white.

(181) 1899 **Cushing, H. P.** Portion of Potsdam and Pierrepont townships, St Lawrence county. Geol. Rep't 16 (1896). 1899. p. 25; *also* Mus. Rep't 50 (1896). 1899. 2 : 25. Scale 1 in. = $\frac{2}{3}$ m. Shows outcrops and quarries in black and white.

(182) 1899 ——— *Geological map of Franklin county.* Geol. Rep't 18 (1898). 1899 (in cover); *also* Mus. Rep't 52 (1898). 1900. v. 2 (in cover). Scale 1 in. = 5 m. A colored geologic map. 29 x 39 cm.

(183) 1899 ——— Map of St Lawrence and Franklin counties. Geol. Rep't 16 (1896). 1899. Facing p. 4; *also* Mus. Rep't 50 (1896). 1899. v. 2, facing p. 4. Scale 1 in. = 5 m. Shows in black and white the outcrops of the various formations.

(184) 1899 **Dale, T. N.** *Map of Slate Belt of Vermont and New York.* U. S. Geol. Sur. 19th An. Rep't 1899. pt 3, p. 176. Scale 1 in. = $2\frac{3}{4}$ m. A colored geologic map on topographic base.

(185) 1899 ——— *Quarry Map of Slate District* (Washington co.). U. S. Geol. Sur. 19th An. Rep't. 1899. pt 3, p. 268. Scale 1 in. = $\frac{1}{2}$ m. Shows part of eastern Washington co. A colored geologic and topographic map.

(186) 1899 ——— *Map of Hampton and Granville Showing Slate Quarries* (Washington co.). U. S. Geol. Sur. 19th An. Rep't pt 3. 1899. p. 266. Scale 1 in. = $\frac{1}{2}$ m. A colored geologic and topographic map.

(187) 1899 **Fairchild, H. L.** *Map Showing Shore Lines and Outlets of Glacial Lakes in Central New York.* Am. Jour. Sci. ser. 4. 1899. v. 7, pl. 6. Scale 1 in. = 8 m. A black and white map.

(188) 1899 **Fisher, W. L.** *Geologic Map of Delaware County.* Geol. Rep't 17 (1897). 1899. Facing p. 104; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 104. Scale 1 in. = 5 m. Colored geologic map. 32 x 34 cm.

(189) 1899 **Grabau, A. W.** Map of Hamburg township, Erie county. Geol. Rep't 16 (1896). 1899. Facing p. 230; *also* Mus. Rep't 50 (1896). 1899. v. 2, facing p. 230. A black and white map showing outcrops of Hamilton group.

(190) 1899 **Kemp, J. F.** *Map of Lake Sanford (Essex co.) Region Showing Location of Ore Bodies.* U. S. Geol. Sur. 19th An. Rep't pt 3. 1899. Facing p. 410.

(191) 1899 ——— *Map of Portions of Elizabethtown and Westport* (Essex co.). U. S. Geol. Sur. 19th An. Rep't pt 3. 1899. p. 398. Scale 1 in. = 1 m. A colored geologic and topographic map.

(192) 1899 ——— Map of portion of Hamilton co. Geol. Rep't 18 (1898). 1899. Facing p. 141; *also* Mus. Rep't 52 (1898). 1900. v. 2, facing p. 141. Scale 1 in. = $2\frac{1}{2}$ m. A black and white geologic map.

(193) 1899 ——— Map of vicinity of Wells village, Hamilton county. Geol. Rep't 18 (1898). 1899. Facing p. 144; *also* Mus. Rep't 52 (1898). 1900. v. 2, facing p. 144. Scale 1 in. = about $\frac{1}{2}$ m. A black and white geologic map.

(194) 1899 ——— Map of Johnsburg township, Warren county. Geol. Rep't 18 (1898). 1899. Facing p. 158; *also* Mus. Rep't 52 (1898). 1900. v. 2, facing p. 158. Scale 1 in. = 2 m. A black and white geologic map.

(195) 1899 ——— Map of Fort Ann township, Washington county. Geol. Rep't 18 (1898). 1899. Facing p. 162; *also* Mus. Rep't 52 (1898). 1900. v. 2, facing p. 162. Scale 1 in. = 2 m. A black and white geologic map.

(196) 1899 ——— & **Newland, D. H.** Map of Long Lake and Indian Lake townships, Hamilton county. Geol. Rep't 17 (1897). 1899. Facing p. 552, *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 552. Scale 1 in. = 6 m. A black and white geologic map.

(197) 1899 ——— Map of Newcomb township, Essex county. Geol. Rep't 17 (1897). 1899. Facing p. 550; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 550. Scale 1 in. = 3 m. A black and white geologic map.

(198) 1899 ——— Map of Minerva township, Essex county. Geol. Rep't 17 (1897). 1899. Facing p. 550; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 548. A black and white geologic map.

(199) 1899 ——— Map of Bolton township, Warren county. Geol, Rep't 17 (1897). 1899. Facing p. 534; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 534. Scale 1 in. = 2¼ m. A black and white geologic map.

(200) 1899 ——— Map of Chester township, Warren county. Geol. Rep't 17 (1897). 1899. Facing p. 536; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 536. Scale 1 in. = 2½ m. A black and white geologic map.

(201) 1899 ——— Map of Hague township, Warren county. Geol. Rep't 17 (1897). 1899. Facing p. 538; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 538.

(202) 1899 ——— Map of Fort Ann township, Washington county. Geol. Rep't 17 (1897). 1899. Facing p. 530; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 530. Scale 1 in. = 2¼ m. A black and white geologic map.

(203) 1899 ——— Map of Whitehall village and ridge to the west. Geol. Rep't 17 (1897). 1899. Facing p. 522; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 522. Scale 1 in. = ½ m. A black and white geologic map.

(204) 1899 ——— Map of Whitehall township, Washington county. Geol. Rep't 17 (1897). 1899. Facing p. 520; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 520. Scale 1 in. = 1¾ m. A black and white geologic map.

(205) 1899 ——— Map of Dresden township, Washington county. Geol. Rep't 17 (1897). 1899. Facing p. 514; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 514. Scale 1 in. = 2¼ m. A black and white geologic map.

(206) 1899 ——— Map of Putnam township, Washington county. Geol. Rep't 17 (1897). 1899. Facing p. 512; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 512. Scale 1 in. = 1¾ m. A black and white geologic map.

(207) 1899 ——— Map of part of Warren county. Geol. Rep't 17 (1897). 1899. Facing p. 546; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 546. Scale 1 in. = 4 m. A black and white geologic map.

(208) 1899 ——— Map of Horicon township, Warren county. Geol. Rep't 17 (1897). 1899. Facing p. 544; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 544. Scale 1 in. = 2 m. A black and white geologic map.

(209) 1899 **Kümmel, H. B.** Map of portion of Tarrytown and Ramapo quadrangles. Geol. Rep't 18 (1898). 1899. (pocket); *also* Mus. Rep't 52 (1898). 1900. v. 2 (in pocket). Scale 1 in. = 1 m. Colored geologic map on topographic base, showing extent of Triassic rocks. 44 x 45 cm.

(210) 1899 ——— *Newark Area of New Jersey and New York.* Jour. Geol. 1899. 7: 23. A small black and white geologic map.

(211) 1899 ——— *Map of Newark Rocks in New York State.* N. J. Geol. Sur. (1898). 1899. p. 46. Scale 1 in. = 5 m. A small black and white geologic map of southeastern New York.

(212) 1899 **Luther, D. D.** Geologic map of the salt region, western and central New York. Geol. Rep't 16 (1896). 1899. Facing p. 172; *also* Mus. Rep't 50 (1896). 1899. v. 2, facing p. 172. Scale 1 in. = 16 m. A colored geologic map including also location of salt wells and mines. 24 x 45 cm.

(213) 1899 **Orton, E.** Portion of Chautauqua county. Mus. Bul. 30. 1899. Facing p. 492; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. 492. Scale 1 in. = 6 m. Colored geologic map Ripley to Irving. 22 x 7 cm.

(214) 1899 **Prosser, C. S.** Map showing distribution of middle and upper Devonian rocks in central New York. Geol. Rep't 17 (1897). 1899. Facing p. 65; *also* Mus. Rep't 51 (1897). 1899. v. 2, facing p. 65. Scale 1 in. = 5 m. A colored geologic map. 61 x 38.5 cm.

(215) 1899 **White, T. G.** *Map of the Vicinity of Frankfort Hill* (Herkimer co.) Mus. Rep't 51 (1897). 1899. Facing p. 154. Scale 1 in. = 1 m. A geologic map on topographic base. 31.5 x 16.5 cm.

(216) 1899 ——— Map of portions of Oneida and Lewis counties. Mus. Rep't 51 (1897). 1899. v. 1, facing p. 154. Scale 1 in. = 2½ m. A black and white geologic map of the Precambric boundary. 16 x 49.5 cm.

(217) 1900 **Clarke, J. M.** *Geological Map of the Becraft Mountain Synclinal,* Columbia county. Mus. Mem. 3. 1900. Facing p. 12; *also* Mus. Rep't 53 (1899). 1901. v. 2, facing p. 12. Scale 1 in. = 120 rd. Black and white map.

(218) 1900 **Prosser, C. S.; Cumings, (E. R.) & Fisher, (W. L.).** Geologic map of Amsterdam quadrangle. Mus. Bul. 34. 1900 (in cover); *also* Mus. Rep't 54 (1900). 1902. v. 1, facing p. 484. Scale 1 in. = 1 m. Colored geologic map on topographic base. 33 x 44.5 cm.

(219) 1900 **Ries, H.** Map of New York State showing location of clay and shale deposits and factories. Mus. Bul. 35. 1900 (in cover); *also* Mus. Rep't 54 (1900). 1902. v. 2 (in cover). Scale 1 in. = 12 m. 93.5 x 69.5 cm.

(220) 1901 **Cushing, H. P.** *Geological Map of Part of Clinton County.* Geol. Rep't 19 (1899). 1901. Facing p. r40; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r40. Scale 1 in. = 5 m. A colored geological map.

(221) 1901 ——— *Geological Map of Portion of Clinton County.* Geol. Rep't 19 (1899). 1901. Facing p. r39; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r39. Scale 1 in. = 1 m. A colored geologic map on topographic base, accompanied by 3 sections.

(222) 1901 **Grabau, A.** Map of Niagara river and vicinity. Mus. Bul. 45. 1901 (in cover); *also* Mus. Rep't 54 (1900). 1902. v. 4 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base. 38 x 84.5 cm.

(223) 1901 **Greenwood, J. W.** Map of oil territory of Allegany county. Geol. Rep't 19 (1899). 1901. Facing p. r107; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r107. Scale 1 in. = $3\frac{1}{4}$ m. A black and white map showing proven oil and gas territory. 17 x 25.5 cm.

(224) 1901 **Kemp, (J. F.) & Hill, (B. F.).** Map of Caldwell township, Warren county. Geol. Rep't 19 (1899). 1901. Facing p. r22; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r22. Scale 1 in. = $1\frac{1}{4}$ m. A black and white geologic map.

(225) 1901 ——— Map of the "Noses," Montgomery and Fulton counties. Geol. Rep't 19 (1899). 1901. Facing p. r32; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r32. Scale 1 in. = 1 m. Shows outcrops of Granville gneiss along Erie canal on topographic base.

(226) 1901 ——— Map of northern Fulton county. Geol. Rep't 19 (1899). 1901. Facing p. r29; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r29. Scale 1 in. = 5 m. A black and white geologic map.

(227) 1901 ——— Map of northern Saratoga county. Geol. Rep't 19 (1899). 1901. Facing p. r28; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r28. Scale 1 in. = 4 m.

(228) 1901 ——— Map of Queensbury township, Warren county. Geol. Rep't 19 (1899). 1901. Facing p. r26; *also* Mus. Rep't 53 (1899). 1901. v. 2, facing p. r26. Scale 1 in. = 2 m. A black and white geologic map.

(229) 1901 **Leverett, (F.) & Taylor, (F. B.).** Pleistocene maps of western New York. U. S. Geol. Sur. Monogr. 41. 1901. pl. 21, 23, 26. Various maps showing the extent of glacial lakes.

(230) 1901 **Leverett, F.** Map showing glaciated area of Olean quadrangle. U. S. Geol. Sur. Monogr. 41. 1901 (in pocket). Scale 1 in. = 1 m. A topographic map showing the glaciated and nonglaciated area of the district.

(231) 1901 ——— A pleistocene map of central United States. U. S. Geol. Sur. Monogr. 41. 1901. pl. 2. Shows glacial deposits in western New York in colors.

(232) 1901 ——— *Pleistocene Features Southeast of Buffalo.* U. S. Geol. Sur. Monogr. 41. 1901. pl. 25. Scale 1 in. = 2¾ m. A colored map.

(233) 1901 ——— *Pleistocene Map of Part of Dunkirk, Cherry Creek and Silver Creek Quadrangles.* U. S. Geol. Sur. Monogr. 41. 1901. pl. 19. Scale 1 in. = 2¾ m. A colored pleistocene map on topographic base.

(234) 1901 ——— Map of portions of Pennsylvania, Ohio and New York. U. S. Geol. Sur. Monogr. 44. 1901. pl. 15. Scale 1 in. = 20 m. Shows in colors the pleistocene features of southwestern New York.

(235) 1901 ——— *Pleistocene Map of the District between Niagara River and Rochester.* U. S. Geol. Sur. Monogr. 41. 1901. pl. 3. Scale 1 in. = 3 m. A colored pleistocene map on topographic base.

(236) 1901 **Merrill, F. J. H.** *Geologic Map of New York State.* Issued separately with accompanying description. Mus. Bul. 56. 1902. Scale 1 in. = 5 m.

(237) 1901 **Ries, H.** Map of New York State showing location of limestone quarries, marl beds and cement plants. Mus. Bul. 44. 1901 (in cover); *also* Mus. Rep't 54. (1900). 1902. v. 3 (in cover). Scale 1 in. = 12 m. 72 x 74 cm.

(238) 1901 ——— Map of New York State showing limestone formations. Mus. Bul. 44. 1901 (cover); *also* Mus. Rep't 54 (1900). 1902. v. 3 (in cover). Scale 1 in. = 24 m. A colored geologic map of the various limestones of the State. 44.5 x 35 cm.

(239) 1901 **Ruedemann, R.** Map of portion of Albany and Rensselaer counties. Mus. Bul. 42. 1901. Facing p. 480; *also* Mus. Rep't 54 (1900). 1902. v. 3, facing p. 480. Scale 1 in. = 1 m. A colored stratigraphic map showing subdivisions of the Hudson River beds. 24.5 x 51.5 cm.

(240) 1901 **Smyth, (C. H. jr).** *Geologic Map of Portions of St Lawrence and Jefferson Counties.* Geol. Rep't 19 (1899). 1901. Facing p. r85; *also* Mus. Rep't 53 (1899). 1901. v. 1, facing p. r85. Scale 1 in. = 2½ m. A colored geologic map. 16.5 x 26.5 cm.

(241) 1901 **Woodworth, J. B.** Map of Oyster Bay and Hempstead quadrangles, Long Island. Mus. Bul. 48. 1901 (in cover); *also* Mus. Rep't 54 (1900). 1902. v. 4 (in cover). Scale 1 in. = 1 m. A colored pleistocene map, on a topographic base. 35 x 71 cm.

(242) 1902 **Cushing, H. P.** *Geologic Map of the vicinity of Saranac Lakes.* Mus. Rep't 54 (1900). 1902. v. 1, facing p. r25. Scale 1 in. = 5 m. A colored geologic map.

(243) 1902 **Eckel, E. C.** *Quarry Map of Southeastern New York.* Geol. Rep't 20 (1900). 1902. Facing p. r143; *also* Mus. Rep't 54 (1900). 1902. v. 1, facing p. r143. Scale 1 in. = 5 m. Location of quarries in red on plain map. 28.5 x 38 cm.

(244) 1902 **Finlay, G. I.** Geologic map of Minerva township, Essex county. Geol. Rep't 20 (1900). 1902. Facing p. 1102; *also* Mus. Rep't 54 (1900). 1902. v. 1, facing p. 1102. Scale 1 in. = $2\frac{3}{4}$ m. A colored geologic map.

(245) 1902 **Hollick, (A.) & Merrill, (F. J. H.).** Map of Staten Island quadrangle. Historical geology sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(246) 1902 **Merrill, F. J. H.** Map of Brooklyn quadrangle — Historical geology sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(247) 1902 ——— **& assistants.** Map of Harlem quadrangle — Structure section sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored geologic map with interpolated sections.

(248) 1902 ——— Geologic map of Harlem quadrangle. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. Colored geologic map on topographic base.

(249) 1902 **Salisbury, (R. D.) & Peet, (C. E.).** Map of Staten Island quadrangle — Surficial geology sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored pleistocene map on topographic base.

(250) 1902 ——— Map of Brooklyn quadrangle — Surficial geology sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored pleistocene map on topographic base.

(251) 1902 ——— **& Kümmel, (H. B.).** Map of Harlem quadrangle — Surficial geology sheet. U. S. Geol. Sur. Folio 83. 1902. Scale 1 in. = 1 m. A colored pleistocene map on topographic base.

(252) 1902 **van Ingen, G.** Map of portions of Clinton and Essex county. Mus. Bul. 53. 1902. Facing p. 539; *also* Mus. Rep't 55 (1901). 1903. Facing p. 539. Scale 1 in. = 1 m. Outcrops of Beekmantown and Potsdam formation in colors on topographic map.

(253) 1903 **Clarke, J. M.** Map of New York State showing location of mastodon remains. Mus. Bul. 69. 1903. p. 921; *also* Mus. Rep't 56 (1902). 1904. v. 2, facing p. 921. Scale 1 in. = 60 m.

(254) 1903 ——— **Glenn, (L. C.) & Butts, (C.).** Geologic map of Olean quadrangle. Mus. Bul. 69. 1903 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 2 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base. 34.5 x 45.5 cm.

(255) 1903 ——— **& Luther, (D. D.).** Map of Union Springs and vicinity. Mus. Bul. 69. 1903. Facing p. 131; *also* Mus. Rep't 56 (1902). 1904. v. 2. Scale 1 in. = 1 m. A colored geologic map on topographic base. 18.5 x 22 cm.

(256) 1903 ——— Stratigraphic map of the Portage divisions west of Seneca lake. Mus. Bul. 69. 1903 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 2 (in cover). Scale 1 in. = 10 m. The various divisions of the Portage indicated in colors. 25 x 54 cm.

(257) 1903 **Cleland, H. F.** *Geologic Map of the Cayuga Lake Region.* U. S. Geol. Sur. Bul. 216. 1903. Facing p. 14. Scale 1 in. = 6 m. A colored geologic map.

(258) 1903 **Dickinson, H. T.** Map of the bluestone region of the eastern Catskills. Mus. Bul. 61. 1903 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 1 (in cover). Scale 1 in. = 1 m. Map showing quarries and ledges of bluestone on the topographic base. 45 x 45.5 cm.

(259) 1903 ——— Map of New York State showing Hamilton group and bluestone quarries. Mus. Bul. 61. 1903 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 1. Scale 1 in. = 12 m. On railroad map the lower boundary of the Hamilton group is indicated together with the location of bluestone quarries. 64.5 x 72 cm.

(260) 1903 **Glenn, (L. C.) & Butts, (C.).** Geologic map of Salamanca quadrangle. Mus. Bul. 80. 1903 (in cover); *also* Mus. Rep't 57. (1903). 1905. pt 1, v. 1 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base.

(261) 1903 **Grabau, A. W.** Map of Becraft mountain in Columbia county. Mus. Bul. 69. 1903 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 2 (in cover). Scale 1 in. = 6 m. A colored stratigraphic and paleontologic map on topographic base, accompanied by two section sheets. 32 x 42 cm. 15 x 36.5 cm. 60 x 19 cm.

(262) 1903 **van Ingen, (G.) & Clark, (P. E.).** Map of region around Rondout. Mus. Bul. 69. 1903. Facing p. 1178; *also* Mus. Rep't 56 (1902). 1904. v. 2. Scale 1 in. = 1140 ft. A black and white geologic map with sections.

(263) 1903 **Woodworth, J. B.** Map of part of Northumberland township. Geol. Rep't 21 (1901). 1903. Facing p. 116; *also* Mus. Rep't 55 (1901). 1903. Facing p. 116. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(264) 1903 ——— Map of Starr's Knob, Northumberland. Geol. Rep't 21 (1901). 1903. Facing p. 118; *also* Mus. Rep't 55 (1901). 1903. p. 118. A small black and white geologic map.

(265) 1904 **Adams, G. I.** *et al.* *Map Showing Area of Salina Group in Central New York and Gypsum Producing Localities.* U. S. Geol. Sur. Bul. 223. 1904. Facing p. 34. Scale 1 in. = 30 m. A black and white map.

(266) 1904 **Clarke, (J. M.) & Luther, (D. D.).** Geologic map of Canandaigua and Naples quadrangles. Mus. Bul. 63. 1904 (in cover); *also* Mus. Rep't 56 (1902). 1904. v. 2 (cover). Scale 1 in. = 1 m. A colored geologic map on a topographic base.

(267) 1904 ——— Map of western New York showing the Portage division. Mus. Mem. 6. 1904. Facing p. 198; *also* Mus. Rep't 57 (1903). 1905. pt 3, facing p. 198. A colored stratigraphic map of the Portage division, Seneca lake to Lake Erie.

(268) 1904 **Dale, T. N.** *Hudson Valley from the Hoosic River to Kinderhook Creek.* U. S. Geol. Sur. Bul. 242. 1904. Facing p. 12. Scale 1 in. = 2 m. A colored geologic map on topographic base.

(269) 1904 **Bishop, I. P.** (**From Greenwood, J. W., 1899**). Maps of proven oil and gas territory in Allegany and Cattaraugus counties. Geol. Rep't 22 (1902). 1904. Facing p. r43; *also* Mus. Rep't 56 (1902). 1904. v. 1, facing p. r43. Scale 1 in. = 4 m. A black and white map.

(270) 1904 **Sarle, C. J.** Map of Monroe county showing mineral resources. Geol. Rep't 22 (1902). 1904. Facing p. r75; *also* Mus. Rep't 56 (1902). 1904. v. 1, facing p. r75. Scale 1 in. = 5 m. The mineral resources indicated in red on a plain map.

(271) 1905 **Clarke (J. M.) & Luther, (D. D.).** Geologic map of Tully quadrangle. Mus. Bul. 82. 1905 (in cover); *also* Mus. Rep't 58 (1904). 1906. v. 2. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(272) 1905 ——— Geologic map of Watkins-Elmira quadrangles. Mus. Bul. 81. 1905 (in cover); *also* Mus. Rep't 58 (1904). 1906. v. 3. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(273) 1905 **Cushing, H. P.** *Outcrop Map of Portions of the Towns of Chazy and Champlain, Clinton County.* Mus. Bul. 95. 1905. pl. 12; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 406. Scale 1 in. = 1 m. Outcrops indicated in colors.

(274) 1905 ——— *Outcrop Map of Portions of Townships of Plattsburg and Peru, Clinton County.* Mus. Bul. 95. 1905. Facing p. 408; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 408. Scale 1 in. = 1 m. Outcrops indicated in colors.

(275) 1905 ——— Geologic map of Little Falls quadrangle. Mus. Bul. 77. 1905 (in cover); *also* Mus. Rep't 57, v. 1, pt 1 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base. Accompanied by a section sheet.

(276) 1905 **Dale, T. N.** *Map of the Taconic Region.* U. S. Geol. Sur. Bul. 272. 1905. Facing p. 10. Scale 1 in. = 5½ m. Shows relief and kinds of rock. A lithologic map.

(277) 1905 (1892) ——— **& Prindle, (L. M.).** Geologic map of portions of Beekmantown and Pawling townships, Dutchess co. Geol. Rep't 23 (1903). 1905. Facing p. 195; *also* Mus. Rep't 57 (1903). 1905. Facing p. 195. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(278) 1905 **Darton, N. H.** Geologic map of Mohawk valley. Mus. Bul. 95. 1905. Facing p. 410; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 410. Scale 1 in. = 8 m. A colored geologic map. Reprint with slight changes from 14th An. Rep't State Geol. 1894.

(279) 1905 **Merrill, F. J. H.** *Map of New York State Showing Location of all Economic Deposits.* Geol. Rep't 23 (1903). 1905 (in cover); *also* Mus. Rep't 57 (1903). 1905 (in cover). Scale 1 in. = 12 m. A plain map showing economic deposits by symbols.

(280) 1905 ——— *Geological Map of New York State.* Mus. Bul. 85. 1905 (in cover); *also* Mus. Rep't 58 (1904). 1906. v. 2 (in cover). Scale 1 in. = 14 m. A reprint of No. 117. Shows geologic features and location of all economic deposits.

(281) 1905 ——— **& Magnus, (H. C.).** Map of Rye, N. Y. and vicinity (Westchester co.). Geol. Rep't 23 (1903). 1905. Facing p. 193; *also* Mus. Rep't 57 (1903). 1905. Facing p. 193. Scale 1 in. = 1 m. A geologic map on topographic base.

(282) 1905 **Ogilvie, I. H.** Geologic map of Paradox Lake quadrangle. Mus. Bul. 96. 1905 (in cover); *also* Mus. Rep't 58 (1904). 1906. v. 1 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base.

(283) 1905 **Shimer, H. W.** Map of Trilobite mountain, Orange county. Mus. Bul. 80. 1905. Facing p. 175; *also* Mus. Rep't 57 (1903). 1905. pt 1, v. 1, facing p. 175. Scale 1 in. = ⅓ m. A black and white geologic map.

(284) 1905 **Woodworth, J. B.** Map of Hudson River and Lake Champlain area. Mus. Bul. 84. 1905. Facing p. 190; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 190. Scale 1 in. = 40 m. Glacial deposits indicated in red on a topographic map.

(285) 1905 ——— Map of part of Plattsburg quadrangle. Mus. Bul. 84. 1905. Facing p. 168; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 168. Scale 1 in. = 1 m. Glacial deposits around Port Kent indicated in red on a topographic map.

(286) 1905 ——— Map of part of Port Henry quadrangle. Mus. Bul. 84. 1905. Facing p. 156; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 156. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(287) 1905 ——— Map of part of Ticonderoga quadrangle. Mus. Bul. 84. 1905. Facing p. 154; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p.154. Scale 1 in. = 1 m. Glacial deposits around Crown Point and Street-Road indicated in red on a topographic map.

(288) 1905 ——— Map of portion (central) of Glens Falls quadrangle. Mus. Bul. 84. 1905. Facing p. 142; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 142. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(289) 1905 ——— Map of portion (southern) of Glens Falls quadrangle. Mus. Bul. 84. 1905. Facing p. 140; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 140. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(290) 1905 ——— Map of part (northern) of Schuylerville quadrangle. Mus. Bul. 84. 1905. Facing p. 138; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 138. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(291) 1905 ——— Map of part (central) of Schuylerville quadrangle. Mus. Bul. 84. 1905. Facing p. 136; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 136. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(292) 1905 ——— Map of part of Troy quadrangle. Mus. Bul. 84. 1905. Facing p. 124; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 136. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(293) 1905 ——— Map of part of Catskill quadrangle. Mus. Bul. 84. 1905. Facing p. 122; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 122. Scale 1 in. = 1 m. Glacial deposits indicated in red on topographic map.

(294) 1905 ——— Map of part of Rhinebeck quadrangle. Mus. Bul. 84. 1905. Facing p. 120; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 120. Scale 1 in. = 1 m. A glacial terrace at Hyde Park indicated in red on a topographic map.

(295) 1905 ——— Map of part of Poughkeepsie quadrangle. Mus. Bul. 84. 1905. Facing p. 118; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 118. Scale 1 in. = 1 m. Glacial terraces around New Hamburg indicated in red on a topographic map.

(296) 1905 ——— Map of part of Newburgh quadrangle. Mus. Bul. 84 1905. Facing p. 116; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 116. Scale 1 in. = 1 m. Glacial deposits indicated in red on a topographic map.

(297) 1905 ——— Map of part of West Point quadrangle. Mus. Bul. 84. 1905. Facing p. 112; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 112. Scale 1 in. = 1 m. Glacial deposits indicated in red on a topographic map.

(298) 1905 ——— Map of part of Tarrytown quadrangle. Mus. Bul. 84. 1905. Facing p. 94; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 94. Scale 1 in. = 1 m. Glacial deposits indicated in red on a topographic map.

(299) 1905 ——— Map of surficial geology of the Mooers quadrangle. Mus. Bul. 83. 1905 (in cover); also Mus. Rep't 58 (1904). 1906. v. 1 (in cover). Scale 1 in. = 1 m. A colored surficial geologic map on topographic base.

(300) 1905 ——— Map of Chazy and Beekmantown townships, Clinton county. Mus. Bul. 83. 1905. Facing p. 13; *also* Mus. Rep't 58 (1904). 1906. v. 1, facing p. 13. Scale 1 in. = 1 m. The "Ingraham esker" indicated in green on a topographic map.

(301) 1906 **Graubau, A. W.** Geologic map of Schoharie and Cobleskill valleys. Mus. Bul. 92. 1906 (in cover); *also* Mus. Rep't 58 (1904). 1906. v. 3 (in cover). Scale 1 in. = 1 m. A colored geologic map on topographic base.

(302) 1906 **Luther, D. D.** Geologic map of Penn Yan and Hammondsport quadrangles. Mus. Bul. 101. 1906; *also* Mus. Rep't 59, v. 2. Scale 1 in. = 1 m. A colored geologic map on topographic base. Accompanied by one section sheet.

(303) 1906 ——— **& Bishop, (I. P.).** Geologic map of the Buffalo quadrangle. Mus. Bul. 99. 1906; *also* Mus. Rep't 59. v. 2. Scale 1 in. = 1 m. A colored geologic map on topographic base.

(304) 1907 **Berkey, C. P.** Map of southeastern New York. Mus. Bul. 107. 1907. p. 363; *also* Mus. Rep't 60 (1906). 1908. v. 2, p. 363. Scale 1 in. = 10 m. A black and white map showing extent of Harrison diorite, Cortlandt series, etc.

(305) 1907 **Cushing, H. P.** Geologic map of Long Lake quadrangle. Mus. Bul. 115. 1907 (in cover); *also* Mus. Rep't 60 (1906). 1908. v. 2 (cover). Scale 1 in. = 1 m. A colored geologic map on topographic base.

(306) 1907 **Fairchild, H. L.** Map of part of Pulaski quadrangle. Mus. Bul. 111. 1907. pl. 5; *also* Mus. Rep't 60 (1906). 1908. v. 2, after p. 394. Scale 1 in. = 1 m. Shows distribution of drumlins, on a topographic map.

(307) 1907 ——— Map of part of Fulton quadrangle. Mus. Bul. 111. 1907. pl. 6; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 296. Scale 1 in. = 1 m. Shows distribution of drumlins near Oswego, on a topographic map.

(308) 1907 ——— Map of part of Macedon quadrangle. Mus. Bul. 111. 1907. pl. 15; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 406. Scale 1 in. = 1 m. Shows distribution of drumlins around Walworth, on a topographic map.

(309) 1907 ——— Map of part of Albion quadrangle. Mus. Bul. 111. 1907. pl. 17; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 410. Scale 1 in. = 1 m. Shows distribution of drumlins around Elba, Genesee county, on a topographic map.

(310) 1907 ——— Map of part of Caledonia quadrangle. Mus. Bul. 111. 1907. pl. 20; *also* Mus. Rep't 60 (1906). 1908. v. 2, after p. 414. Scale 1 in. = 1 m. Shows distribution of drumlins around Linwood.

(311) 1907 ——— Map of central and western New York. Mus. Bul. 111. 1907. pl. 1; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 391. Scale 1 in. = 12 m. Distribution of drumlins shown on topographic map.

(312) 1907 ——— A part of the Buffalo quadrangle. Mus. Bul. 106. 1907. Facing p. 76; *also* Mus. Rep't 59 (1905). 1907. v. 1, facing p. 76. Scale 1 in. = 1 m. Bars of Lake Dana plotted on a topographic map.

(313) 1907 ——— Map of part of Silver creek quadrangle. Mus. Bul. 106. 1907. Facing p. 74; *also* Mus. Rep't 59 (1905). 1907. v. 1, facing p. 74. Scale 1 in. = 1 m. Glacial deposits indicated on a topographic map.

(314) 1907 ——— Map of parts of Silver creek and Cherry creek quadrangles. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 1 m. Various glacial deposits indicated on a topographic map.

(315) 1907 ——— Map of parts of Westfield and Dunkirk quadrangles. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 1 m. Glacial deposits indicated on a topographic map.

(316) 1907 ——— Map of part of western New York. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 5 m. Glacial deposits indicated in colors on a plain map.

(317) 1907 ——— Map of part of Erie county. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 1 m. Glacial deposits indicated on a topographic map.

(318) 1907 ——— Map of Attica, Depew and part of Buffalo quadrangles. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 1 m. Glacial deposits indicated on a topographic map.

(319) 1907 ——— Map of Batavia and part of Caledonia quadrangles. Mus. Bul. 106. 1907 (in cover); *also* Mus. Rep't 59 (1905). 1907. v. 1 (in cover). Scale 1 in. = 1 m. Glacial deposits indicated on a topographic map.

(320) 1907 ——— Map of central New York. Mus. Bul. 111. 1907. pl. 2; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 392. Scale 1 in. = 22 m. A black and white map showing various glacial phenomena.

(321) 1907 **Hartnagel, C. A.** Geologic map of Rochester and Ontario Beach quadrangles. Mus. Bul. 114. 1907 (in cover); *also* Mus. Rep't 60 (1906). 1908. v. 1 (cover). A colored geologic map on a topographic base.

(322) 1907 ——— Map of Cornwall station and vicinity, Orange county. Mus. Bul. 107. 1907; *also* Mus. Rep't 60 (1906). 1908. v. 2, facing p. 42. Scale 1 in. = $\frac{1}{4}$ m. A colored geologic map on topographic base.

(323) 1908 **Clarke, (J. M.) & Luther, (D. D.).** Geologic map of Letchworth Park, Portageville. Mus. Bul. 118. 1908; *also* Mus. Rep't 60 (1906). 1908. v. 1 (cover). Scale about 1 in. = $\frac{1}{4}$ m. A colored geologic map of the Park and vicinity.

(324) 1908 **Horsford, E. N.** *Geology of the Genesee River*, Portage to Lake Ontario. Mus. Bul. 111. 1908; *also* Mus. Rep't 60 (1906). 1908. v. 1. Scale about 1 in. = $2\frac{1}{2}$ m. A reproduction of map No. (15) 2d Rep't 4th Dist. 1838.

(325) 1908 **Luther, D. D.** Geologic map of Nunda and Portage quadrangles. Mus. Bul. 118. 1908; *also* Mus. Rep't 60 (1906). 1908. v. 1 (cover). Scale 1 in. = 1 m. A colored geologic map on a topographic base.

(326) 1908 **Newland, D. H.** Map of the Adirondack region. Mus. Bul. 119. 1908. p. 8. Scale 1 in. = about 25 m. A black and white map showing principal formations and the iron ore deposits.

(327) 1908 ——— **& Hartnagel, (C. A.).** Map of parts of Oriskany and Utica quadrangles. Mus. Bul. 123. 1908. p. 60. Scale 1 in. = 1 m. The outcrops of Clinton ore indicated in red on a topographic map.

(328) 1908 ——— Map of New York State. Mus. Bul. 123. 1908. p. 8. Scale about 1 in. = 25 m. The outcrop of Clinton formation indicated in red on a plain map.

(329) 1908 ——— Map of part of Macedon quadrangle. Mus. Bul. 123. 1908. p. 70. Scale 1 in. = 1 m. Line of outcrop of Clinton iron ore indicated in red on a topographic map.

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A PECULIAR LANDSLIP IN THE HUDSON RIVER CLAYS

BY D. H. NEWLAND

The glacial and postglacial clays of the Hudson valley when occurring in large bodies on slopes are very prone to subsidence or flowage and occasionally are precipitated *en masse* as landslides of notable magnitude. There is record of frequent damage by such disturbances to the cities and towns that occupy the terraces along either bank of the Hudson; Albany and Troy, for example, have suffered repeated loss by the disruption of buildings and engineering works founded upon the clays.[1]

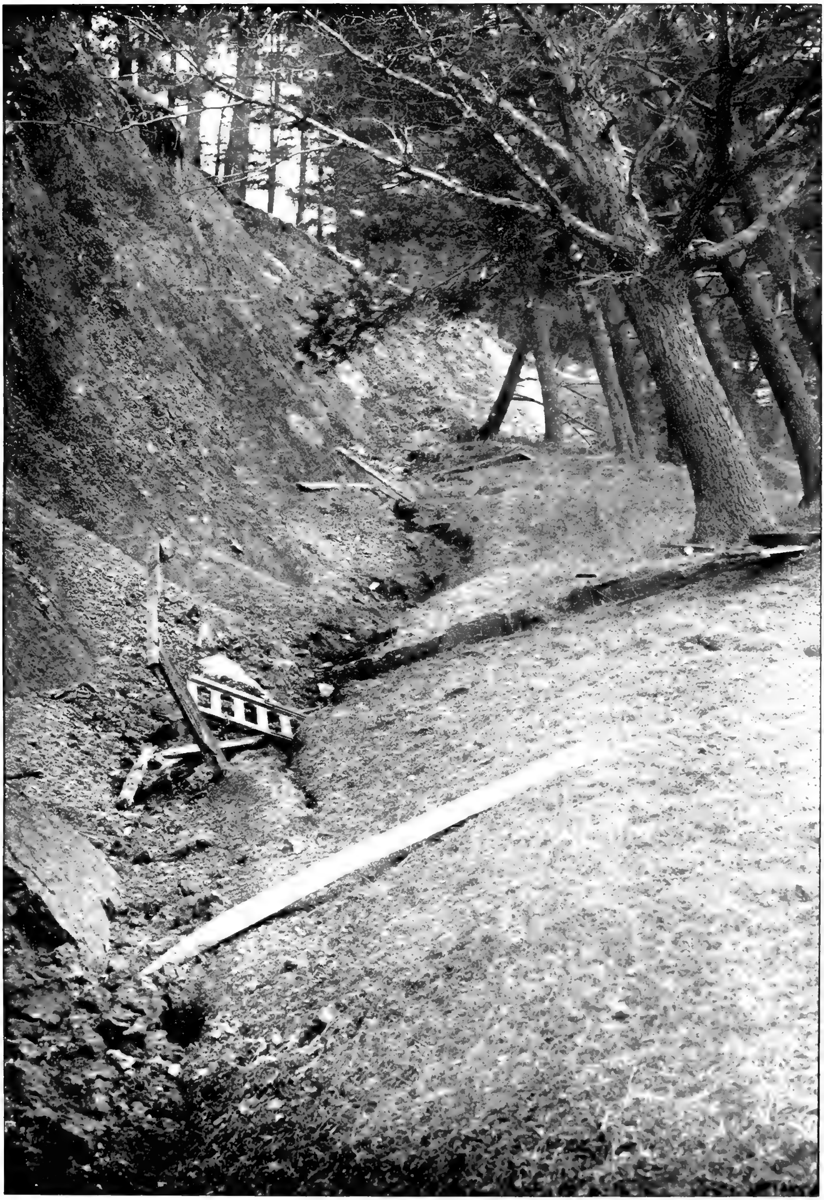
The landslip illustrated herewith took place March 26, 1908, at Stockport, Columbia co., a short distance east of the Hudson river. It involved a relatively small area, and the main interest centers around the peculiar form which it exhibited and the explanation of its origin in the light of surrounding conditions.

In the area south of Stockport creek, below its junction with Claverack creek, there is a terrace lying at about the 100-foot contour, or at a like elevation above the Hudson of which it forms the bank for some distance. The terrace has been dissected by small streams that in places have cut deeply into the clays, though it still presents a fairly uniform surface with an abrupt descent to the valley bottoms on the north and west. One of the small streams on the north side leads through a ravine past Stockport cemetery to enter Stockport creek opposite Columbiaville. The northern bank of this ravine, which was involved in the slip, rises from 60 to 75 feet and is made up of well stratified clays resting upon the Hudson River shale. The shale, however, is not exposed within the ravine, so that the whole thickness of the clays can not be stated.

The subsidence, as appears from the accompanying illustrations, assumed the form of a block fault. A section of the bank 250

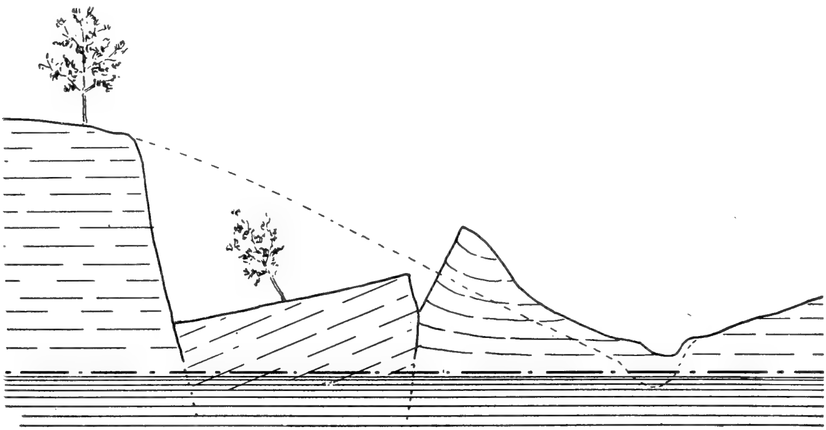
[1] Several landslides are mentioned in Mather's report on the first district (1843). The most notable one occurred at Troy on January 1, 1837, and involved a mass of clay estimated at 200,000 tons which was loosened from the face of a terrace and was precipitated a distance of 800 feet toward the river, sweeping away houses in its course and destroying several lives. By another landslip on March 17, 1859, a building in course of erection for St Peter's College at Troy was demolished. In Albany many small slips and subsidences have occurred, as shown by the displaced or cracked walls of buildings. A recent example was the subsidence of a bank of clay on the north side of Elk street, whereby a whole row of houses was displaced and rendered uninhabitable.

Plate 1



Landslip at Stockport, N. Y. Looking eastward along the northern fracture plane. The tilting of the block is shown by the trees which were left standing in an inclined position.

feet long and from 35 to 50 feet wide was fractured along two approximately parallel lines and the included mass dropped a distance of fully 40 feet along the northern fracture plane. This plane had a slope of 80° toward the ravine. It showed a smooth surface against which the sunken block abutted so closely as to leave no opening. The walls of the second fracture within the ravine inclined away from each other (due to the decided tilt of the fallen block toward the north and the upraising of the adjacent beds) and were separated by a gap 15 feet wide and nearly as deep.



Vertical section across the fault planes. Original slope of hill is indicated by the dotted line, while the heavy broken horizontal line shows the approximate water level.

The clay beds behaved very much like solidified rocks. In their mass they were but little cracked or disturbed by the subsidence. The beds above water level had become fairly dry by evaporation and absorption of moisture by plant growth after the spring rains, so that at the time of the occurrence they must have been firm and tenacious.

The principal factor in determining the nature of the slip was, no doubt, the presence of an underlying mass of water-soaked semiliquid clay beneath the dry upper beds, approximately following the level of the stream. Evidence of this liquid clay was observed in the lowest part of the ravine where a considerable quantity had accumulated by extrusion during the subsidence. The upper beds were thus probably in a state of delicate equilibrium, ready to be precipitated from any slight cause which seems to have been furnished by opening of the parallel fissures some time

before the slip. The ultimate source of strain which gave rise to the fissuring may be found in a possible undermining of the upper beds by underground flowage.

The pressure exerted by the fall of the block was communicated by the semiliquid clay to the beds next to the stream which were raised up and shoved a few feet to the south. The volume of the displacement was estimated roughly at between 4000 and 5000 cubic yards.

There can be little basis for connecting the slip with a movement in the underlying Hudson River shales, though such a relation might be suggested by the known occurrences of postglacial faulting in the region. A rock fault at all commensurate to that observed at the surface would have had far-reaching effects, and even a slight dislocation, such as would supply merely an impulse in precipitating the mass of clay already in delicate equilibrium, could scarcely have happened, for it would have been accompanied by earth tremors of sufficient magnitude at least to have been detected by the seismograph at Albany.

In this connection it may be noted that the slip occurred within a short time after the heavy earthquake of March 26th in southern Mexico. The transmitted vibrations from the earthquake were registered at Albany beginning at 6.10 p. m. Though they were of exceptional magnitude, it would hardly seem justifiable to infer any direct relation between the two phenomena.

The writer is indebted to Mr H. P. Whitlock for the accompanying illustrations and to Mr C. R. Van de Carr, on whose property the landslip occurred, for information and courtesies extended during his visit to the locality.

Plate 2

Landslip at Stockport, N. Y. Opening along southern fracture

SOME ITEMS CONCERNING A NEW AND AN OLD COAST LINE OF LAKE CHAMPLAIN

BY GEORGE H. HUDSON

The summer of 1908 brought the waters of Lake Champlain to a remarkably low level. The *Plattsburg Press* for October 26, 1908 contained the following item:

The water in Lake Champlain has reached the lowest mark. The previous low water mark was made in 1881, but Saturday [October 24, 1908] this mark was passed by a quarter of an inch. Since 1827 it has been the custom of the navigators on the lake to keep a record of the low water reached during the year. In 1827 a low mark was evidently reached, for there is an old bench mark standing at Shelbourne harbor made at that time. October 16, 1881 all records were passed. At that time the steamers of the Champlain Transportation Company were running to Ticonderoga. Pilot E. S. Rockwell of the *Ticonderoga* was on the lake at the time and says that the steamers had to be run into the mud at the Ticonderoga dock in order to have the gang plank reach from the boat to the dock. Pilot Rockwell said that the water was so low that there was only one cut by which the steamers could enter Plattsburg harbor.

On November 16, 1908, the same paper recorded the water level as "two inches below the lowest mark."

In 1905, in a moderately sheltered position and at a level where wave action had kept the rock clean but had failed to cut farther back into the soil covering, a copper bolt was driven into the rock surface of Valcour island to be used as a basis for contour work. On October 10, 1908, the water level of Lake Champlain was 3.107 meters below this bolt and on November 7, 1908, it was 3.186 meters below it. A plank with a painted scale 9 feet long is attached to the steamboat landing at the Plattsburg dock, and on November 28, 1908, the water was 8.9 inches below the foot of this plank and the bottom of the scale. As the water at the time of the spring freshets sometimes completely covers the docks and may rise to or over the 9 foot mark, we may place the distance in level between exceptionally high and exceptionally low water at about 10 feet, and this is but slightly exceeded in the elevation of the bare rock shores of Valcour island where these are due to the annual washing of the waves. Of this exposed surface the upper foot or two may not be covered for some seasons

in succession and the lower foot or two may be free from the action of water only in exceptional seasons.

Plate 1 presents a view taken November 7, 1908. The foreground is near the water level and the little potholes have been filled by the waves of a moderate sea which was running at the time. The upper portions of this exposed rock area are practically as they were left by the Wisconsin ice sheet. These are the portions rarely covered or covered but a month or two in the year. In the immediate foreground the potholes have become confluent and this represents that portion of the rock surface which is rarely uncovered and which has thus been acted upon more persistently by water, wave and undertow. Plate 2 is a view of a portion of this region near the water level of September 27, 1908. The character of the little potholes on the glaciated surface is here better seen as is also their increasing number per unit area, as we reach near the water level of the right-hand lower corner.

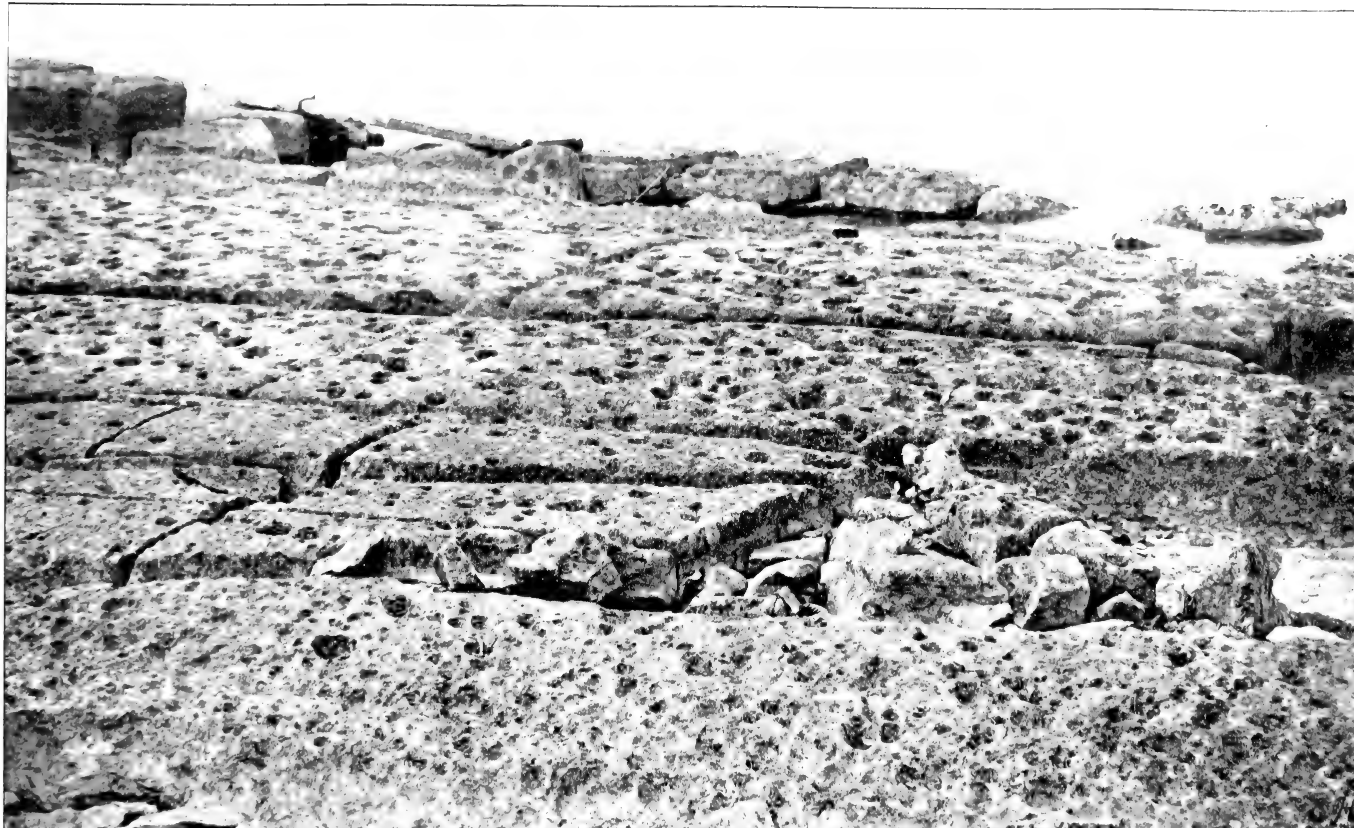
In the bay back of the lighthouse is a very perfect and interesting roche moutoneeée bearing a record which also testifies to present stability of the water level of Lake Champlain. The position is here much more sheltered and the little potholes [*see* pl. 3] do not appear to descend to so great a depth as in the former locality. To the left they occur at a lower level and have become confluent. These little potholes were not cut by pebbles. Not one in several hundreds has a pebble in it and no pebble could have found a lodging on the steep and smooth glaciated sides of these "sheepbacks." They all contain sand however and were cut by water vortexes carrying sand and finer silt. They rarely exceed 12 centimeters in diameter, unless confluent, and many are very much smaller. They are cut also in very steep sides as shown in plate 4, where they appear as glacial sections of small potholes. The maintenance of a water vortex carrying material which ever cuts back and widens the rock at one side, while the other side of the vortex is not inclosed, and which thus continues to develop the vertical and conical character of the excavation, is of special interest.

Potholes are said to "often point to the former existence of rapids or falls" and the term usually carries with it the idea of much larger excavations than those found on the shores of Valcour island. The potholes of rivers and glacial streams are not due to wind action on water and are not confined to one level

Plate 1

Part of a glaciated shoreline in Noel bay, Valcour island, the glaciated surface of the foreground being destroyed by sand cut cup holes. From a photograph taken November 7, 1908

Plate 2



A nearer view of a portion of the territory immediately to the right of that shown in plate 1. From a photograph taken September 27, 1908

Plate 3

View in the bay back of the lighthouse on Valcour island. The small boulders in the foreground are nearly ali from the washed till. From a photograph taken October 17, 1908

Plate 4

The glaciated boss here shown is not the same as that on plate 3 but is from the same bay. A 30 centimeter rule was placed in one of the cup holes. From a photograph taken October 17, 1908

line that may reach many miles. These lake excavations caused by wave and undertow are not only smaller and more shallow than stream potholes but are cut at the same level on a line surrounding a large territory and any higher linear series would be indicative not of the phenomena of former stream action, rapids or falls, but of former wave action. A new term for these shore line excavations would be conducive to clear thinking and on account of their difference in diameter, depth, position, arrangement, locality and manner of formation, a new term is certainly due them. The name *cupholes* is proposed and will be used hereafter.

That these cupholes are due in great measure to vortexes in the undertow from wave action is shown by plate 5, which presents a view of the seaward end of the glaciated rock boss in part shown in plate 3. The cupholes are arranged in curving lines which all run from the central ridge of the rock mound and take the lines of the undertow. Many cupholes may be seen to have become confluent and the figure makes a very interesting study. The absence of pebbles is shown, as is also the presence of minor cupholes within the major.

Just under the edge of the water all the cupholes have become confluent and the result is a distinct shelf, about a foot wide, cut completely around a more exposed portion of this glaciated boss. Just outside the edge of the shelf is a fine clay bottom from which the action of the present low water has removed some few centimeters and cut the surface into a very irregular pattern indicative of varying density. Whether or not Lake Champlain is repeating a former process and removing some of its own sediment or whether the low water is removing the sediment of the Hochelagan sea, where it covers the till, is not at all certain; but the distinct rock shelf cut by the cupholes would indicate that Lake Champlain had never cut lower.

These cupholes may be found around the entire island and extending deepest where the undertow is greatest. There is no higher line shown on the island and the retreating Hochelagan sea found no resting place until the waters were freshened by the stream inflow and the lake reached the present comparatively stable level.

The figures given show in each case glaciated surfaces running from above high water mark to below low water mark. This feature is present to a greater or less degree on every

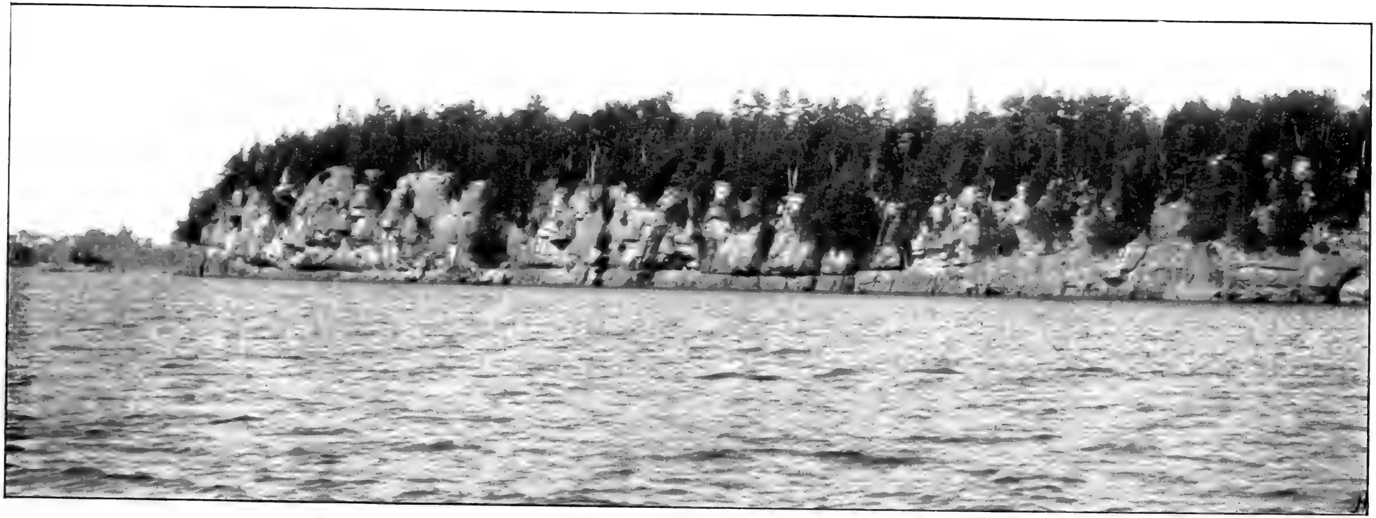
side of the island and in many places the waves have not yet succeeded in removing the till. For instance, in Spoon bay, one may remove the till and find scratched and polished bed rock where the same is covered by water for half the year. Nearly vertical cliffs rise from these beaches and yet the beach shelf is glaciated. Plate 6 shows the character of the western portion of the south cliff. Its upper edges have been rounded by glacial action and but few large fragments of the wall have fallen since glacial time. The eastern part of this cliff, which is nearly as high, has been cut in rocks which dip easterly with sufficient angle to expose strata that reached from the very bottom of the Chazy beds to near their top. This cliff shows abundant signs of glaciation and contains one large pothole about half way down its face. At the base of this cliff is the wave-cut shelf shown partly exposed in plate 7. Within a few feet of where the man is holding an oar, the waves of the low water level have carried away some fallen debris and exposed a bed of glacial till in which the dark, washed, Trenton pebbles (still partially embedded) contrast strongly with the pale, water-eroded surface of the clay. Nearer the bank the clay of the till, at least in its upper portion, is somewhat interstratified with very fine sands due no doubt to glacial drainage over the cliff. Such a drainage is indicated by the pothole. A top dressing a foot and more thick, consisting of fallen fragments from the cliff and heavy, rounded, granitic boulders, about half and half, serves to break the force of the waves and undertow. The heavier masses are well bedded in a coarse gravel which becomes much finer nearer the bottom. The transition from the clean, fine, washed gravel to the clay of the till is sharp and distinct. This till was uncovered and then excavated to the depth of 2 feet in two different places and found to contain only well worn, polished, and scratched pebbles.

The wave-cut bench is here more than 30 meters wide. The cliff at the right is of hardest, massive, middle Chazy and on both sides of this point streams of glacial till have cut down the weaker rocks of the cliff and going seaward lowered the shelf level by from 2 to 4 feet on both sides of the exposed portion shown in plate 7. Plate 8 shows a similar shelf at the same level extending far to the south and west of Garden island. The man in the boat has his oar resting on the rock bottom more than a hundred meters aut. Evidences of preglacial wave-cut shelves

Plate 5

The seaward end of the sheep's back partly shown in plate 3. The shadow at the end is of a person standing in a boat which was held across the front to still the ripples. The divergence of the rows of cup holes is still more marked under water but the water was not quiet enough to allow it to appear in the photograph. Dotted lines have been drawn to express more fully the divergence of the chains of cup holes. From a photograph taken October 24, 1908

Plate 6



Part of the south shore of Valcour island

Plate 7

The wave cut shelf of Lake Valcour is seen, partly submerged, in the vicinity of the boat. The edges of the slightly dipping beds appear somewhat like breaking waves. From a photograph taken October 24, 1908. The atmosphere was full of smoke from Adirondack fires.

Plate 8

The old wave cut shelf of Lake Valcour revealed by the low water. The rock cliff of Garden island is immediately back of the observer. From a photograph taken October 24, 1908. Air filled with smoke from Adirondack fires

are also found at Crab island, Bluff point, Plattsburg, and without doubt may be found elsewhere in the present lake basin. The evidence from Valcour island, however, is in itself sufficient to demonstrate the presence of a preglacial lake which for many thousands of years remained at a stable level very close to that at present attained by Lake Champlain. For this ancient lake the name Lake Valcour is proposed.

TYPES OF INLIERS OBSERVED IN NEW YORK

BY RUDOLF RUEDEMANN

The geology of the State of New York is so varied that it furnishes striking examples of nearly all important geologic phenomena. It is the purpose of this paper to direct attention to the illustrations found here of a group of such phenomena which has hitherto not received the attention it deserves and has therefore been described in a rather loose terminology. These phenomena are the inliers scattered throughout the State which have been currently described or cited as "outliers."

The direct occasion of this note has been the observation of a peculiar group of detached outcrops observed by the writer while engaged in mapping a portion of the Clayton sheet. These were found to be of types (produced by corrasion and solution) not mentioned in the textbooks.

The term inlier originated in England about 50 years ago and Page in his Handbook of Geologic Terms (1865) defines it thus [p. 256]: "Inlier, a term introduced by Mr Drew, of the Geological Survey, to express the converse of outlier. It means . . . a space occupied by one formation which is completely surrounded by another that rests upon it."

This original definition is retained in the *Century Dictionary,* while Shaler, in the *Standard Dictionary,* defines inlier as "A former outlier or uneroded portion of an older rock which, having formed an island or an elevation during some later deposit, has thus become embedded in a younger rock." This definition takes notice of but one of many possible modes of production of inliers.

If we wish to derive the definition by taking the converse of the current one of an outlier [*see* Geikie, *Earth Sculpture*] as "A detached mass of rock resting upon and surrounded on all sides by older rocks" we obtain the following: A detached mass of rock surrounded on all sides by younger rocks that rest upon the unexposed portions of it. There exist, however, as we shall presently see, but a few kinds of inliers that are detached masses, while the great majority are continuous with the mother rock. A definition which is to embrace all these classes must, therefore, be given a wider scope and omit reference to the feature of detachment. For this reason, the definition which we find in Scott's

Introduction to Geology [1907. p. 384] is the most satisfactory.[1] It reads: "Inliers differ from outliers in not necessarily being *isolated masses* of rock, but merely isolated *outcrops* of older beds which are surrounded by newer strata, though underground they may be continuous with very extensive areas of beds. An inlier is thus a larger or smaller mass of rock surrounded by beds which are geologically younger than itself." Three groups of inliers are recognized by Scott, viz those produced by folding (anticlines, domes), by faults ("horsts") and the buried outliers.

A survey of all outcrops of rocks within the State which, being surrounded by beds geologically younger, fall under this definition of inliers, has furnished various expressions of these phenomena which naturally fall into two fundamentally different larger groups as regards their primary causes. The first group is produced solely by the agency of water in its different forms, in either depositing or eroding. We distinguish these as deposition and erosion inliers. The other group is caused by the diastrophism of the earth, resulting in folds and faults.

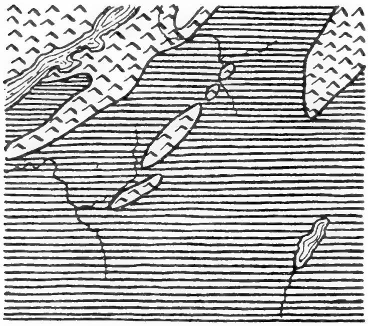
We will now proceed to consider these groups separately. It may, however, be mentioned at the outset that, since nature does not recognize the clean and simple division lines drawn by man, the examples which she furnishes us in this instance are mostly the result of several of the processes here cited as producing inliers, and they will be placed under those agencies which appear to have been most active in their production.

1 **Deposition inliers.** The inliers which are produced by the deposition of newer beds around outliers comprise that form originally and still now most generally understood under the term inliers. As Scott states, "the isolated 'stacks' and pillars on the seacoast are outliers but a movement of depression submerging them in the sea would eventually result in their being buried in newer deposits, thus changing them into inliers." Inliers which originate from true outliers i. e. detached portions of formations, will, in practice, be difficult to distinguish from the second group of deposition inliers, namely, those resulting from the deposition of newer rocks around mere erosional irregularities of still continuous strata, a case that must prevail in all folded regions. We are not aware of instances of the first kind in this State, although the required conditions, i. e. slightly disturbed strata buried by an advancing sea, would seem to have been fulfilled repeatedly in the

[1] *See also* Geikie, J. Structural and Field Geology. 1908.

Helderberg regions. There are, however, good instances of the formation of such inliers, still going on, seen in the islands of our large fresh-water lakes, especially in Lake Champlain, where the islands composed of Paleozoic rocks are being surrounded and gradually buried by the deep alluvial deposits filling up the lake. This is for instance well shown in the case of Valcour island, near the mouth of Ausable river which is rapidly pushing a delta into the lake.

Another group of depositional inliers, however, is well represented in this State. The best instances of this are the numerous hummocks of Grenville and other Precambric rocks protruding through the Potsdam sandstone on the north and especially on the northwest side of the Adirondacks. These are especially well seen in the region south of Alexandria bay [*see* fig. 1, 2]. They originated from the irregular surface of the Precambric floor resulting from the differing hardness of the rocks. The mostly small, elongate hills emerge now from beds of Potsdam sandstone which by their position and the coarser texture of their basal portions, clearly show deposition upon and against these hills. The latter were not true outliers in Potsdam time, since their strata were still in connection with the Adirondack mass, but they have



Inliers of Precambric rocks in Potsdam sandstone near Alexandria, N. Y. Scale 15 m. = 1 in.

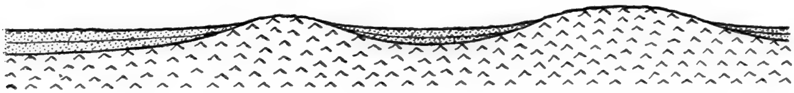


FIG. 2 Diagrammatic section of Precambric inliers near Alexandria, N. Y.

Precambric Potsdam sandstone

become true inliers in the Potsdam formation because exposed again through the agency of erosion. It is then illogical to term these outcrops outliers as is generally done, since they do not fulfil the conditions of an outlier which according to the current conception is a detached mass of rock, resting upon and surrounded on all sides by older rocks. These supposed outliers are only "detached" on the surface, but still connected with the

Adirondack Precambrics under the Potsdam formation, by rocks of the same kind.

Some most interesting examples of the style of inliers last mentioned are observed in the Little Falls sheet, mapped by Professor Cushing. We here especially note the Middleville inlier [*see* text fig. 3, 4]. This is an outcrop of syenite rocks in the bottom of the deep valley of West Canada creek. Although it is obvious that the corrasion by the river is the final cause of the exposure of this rock mass, it follows also from the absence of exposures of the same rock farther up and down the valley, that the syenite here protrudes into the overlying and surrounding Beekmantown beds in consequence of the irregularity of the surface of the Adirondack plateau over which the Beekmantown sea advanced. The syenite is of the same age as the other syenite intrusions associated with the Grenville series of the Adirondacks and a portion of the Adirondack massive. Underground it is

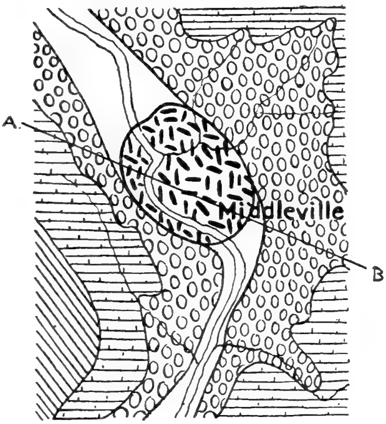


FIG. 3 Inlier of Precambric in Beekmantown limestone at Middleville, N. Y. Scale 1 m. = 1 in.

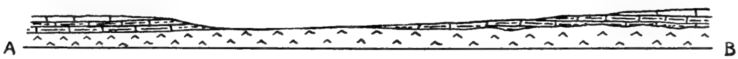


FIG. 4 Section of inlier at Middleville, N. Y.
Precambric Beekmantown

connected with the larger and better known Little Falls inlier consisting of a like syenite. Since the latter, however, is much involved in strong faults and obviously owes much of its prominence to "horst" structure, we will mention it more fully under that caption.

A much smaller group of inliers of Precambric rocks in the Potsdam sandstone similar to those on the northwest and north side of the Adirondacks, is also found on the east side, about Port Henry. The Potsdam there rests as a thin veneer on a steeply tilted fault block and in several places knolls of Precambric rocks which clearly were once small islands in the shallow Potsdam sea, project above the much eroded Potsdam beds [*see* text fig. 5].

As the numerous inliers on the northwest side of the Adirondacks and those of Middleville and Little Falls are only outlying portions

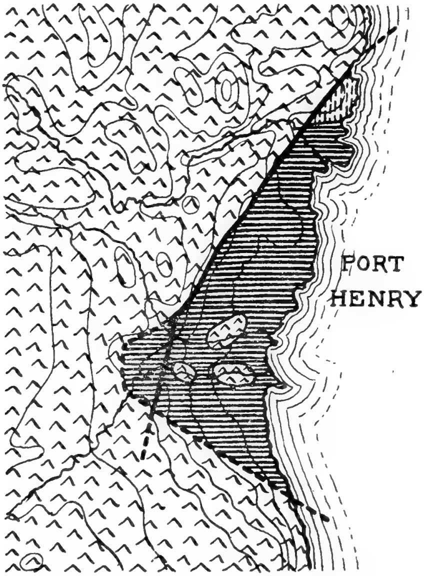


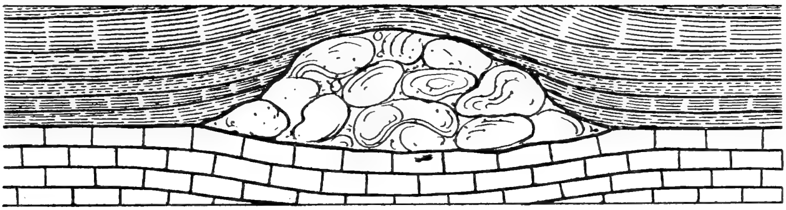
Fig. 5 Inliers of Precambric in Potsdam sandstone at Port Henry, N. Y. Scale 1 m. = 1 in.

of the Adirondack massive, which have become inliers by burial under Paleozoic rocks and subsequent partial exposure by erosion, so the whole Adirondack massive is but an outlying portion of the Canadian shield or protaxis, that once was more or less buried under lower Paleozoic rocks and is now an immense inlier in them. It might be well to distinguish inliers of this magnitude from the smaller ones as *of the first order.* We shall see that the same distinction can be made in regard to the other groups of inliers, and indeed has been made before by Suess in regard to the "horsts."

This Adirondack inlier of the first order which lies at the southeast side of the Canadian shield, has a complete counterpart in another inlier of similar size and corresponding position on the southwest side of the shield in the Wisconsin Precambric area ("Isle Wisconsin"). We consider that the position of these two inliers in regard to the Canadian shield and the Great Lakes indicates a symmetry of structure that is of some im-

portance for the understanding of the geological structure of the eastern United States.

As a third group of depositional inliers may be distinguished the relatively rare and unimportant case where current mounds and ridges have been buried under younger sediments and later become exposed as inliers. An example of this kind is furnished by the Le Claire limestone of Iowa[1] that forms mounds 50 feet high or over and in regard to which it was already suggested by Hall that "at the close of the Niagara huge mounds and ridges were built on the bottom of the shallow Silurian sea, in part by the accumulation *in situ* of corals, crinoids and molluscous shells, and in part by the drift of calcareous sediments under strong currents."



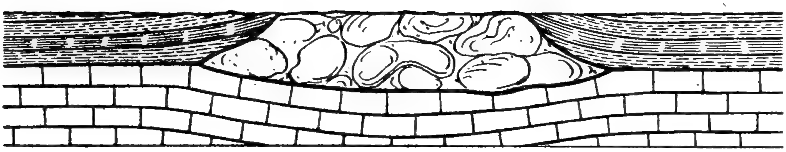


FIG. 6 Lens or reef resting upon Clinton limestone and extending into Rochester shale. (Copy from Sarle)
FIG. 7 Same worn down and forming inlier

As these current mounds later project from the softer and more easily eroded rocks that once buried them, and thus form inliers, so also limestone mounds which grow on the bottom of the ocean through the action of corals, bryozoans and the accumulation of mollusks, may become buried in shales and later project from these as "lenses." Such reef structures have been described by Sarle[2] as reefs in the Clinton formation of western New York. When they indicate an older horizon than the overlying shale, they constitute true inliers. This is frequently the case in western New York, where they represent the top of the Clinton limestone and

[1] Iowa Geol. Sur. Rep't, 11:305.
[2] Sarle, C. J. Amer. Geol. 1901. 28:282.

project into the Niagaran Rochester shale. One may then find, on abraded surfaces, as at Lockport, the lens contrasting as a white inlier with the dark shale [*see* text fig. 6, 7].

2 **Erosion inliers.** We distinguish in this class between *corrasion inliers* which have resulted from river corrasion; *solution inliers;* and *glacial erosion inliers* in which the ice is thought to have been the exposing agent.

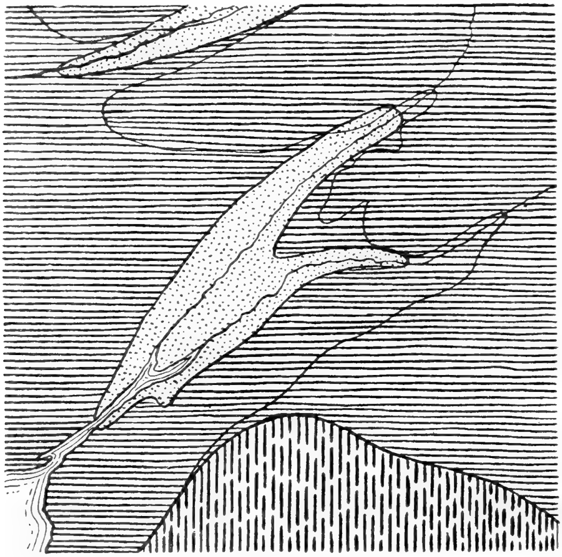


FIG. 8 Inlier of Lowville limestone in Black River limestone at the head of Guffin bay, Jefferson county, N. Y. Scale 1 m. = 1 in.

a Corrasion inliers. The first group we have found excellently exemplified in small and simple forms in the southern portion of the Clayton sheet. As the sketch maps inserted indicate [*see* text fig. 8, 9, 10], these inliers consist of strips of Lowville limestone exposed along brooks and surrounded on all sides by Black River limestone. The conditions which have produced this peculiar form of inlier — which judging from our maps is very rarely seen in other parts of the State — are the following: The coincidence of the dip of the beds and of the course of the brook and a resistance of the underlying Lowville limestone to erosion that is greater than that of the Black River beds. The brook, as a rule, reaches the inlier by a fall and finally leaves it by very gradually passing again upon the overlying rock [*see* text fig. 10, p. 172]. That means that for some distance the gradient of the brook is

greater than the dip of the rocks, but finally falls again below the dip, as in the Chaumont inlier where the brook

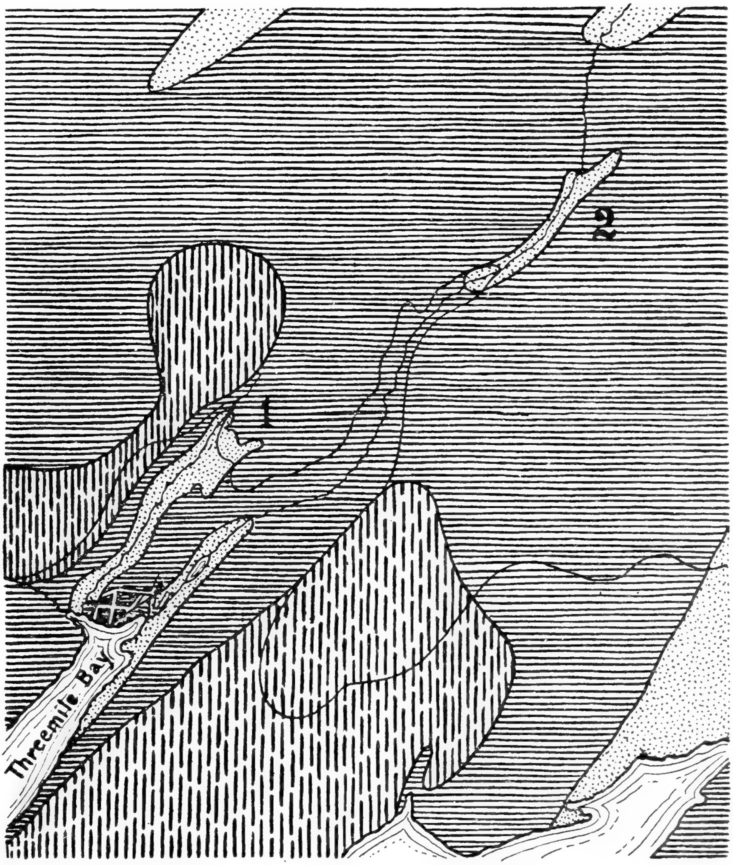


FIG. 9 Three Mile Bay inlier (1) and Three Mile Creek inlier (2) in Jefferson county, N. Y. Lowville limestone. Black River limestone.
Scale 1 m. = 1 in.

reaches the backwater of the lake.[1] It follows from this description of this group of inliers that we can expect to find them only where they follow the dip of the rocks, i. e. in New York, in general in north-south flowing rivers. Among these there occur some very interesting examples of erosion inliers, and more will undoubtedly become known as accurate and detailed mapping pro-

[1] Taking this explanation of this inlier as granted, and also the postglacial age of the brook, then it follows that since the lake water is now backing up into the inlier, the lake must have been rising relatively to the land since the formation of the inlier.

ceeds. The largest one, a most striking example of this kind, is the inlier of Beekmantown rocks along West Canada creek, extending

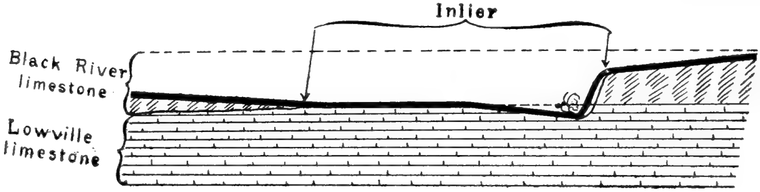


FIG. 10 Diagrammatic section of Three Mile Creek inlier. The black line indicates the creek.

about 12 miles from above Poland to a few miles below Middleville [*see* text fig. 11]. Above the inlier the river flows on Trenton limestone and below on alluvium, which, however, rests quite surely on Trenton and younger rocks, as evidenced by Cushing's map of the Little Falls quadrangle. If it should continue down the river, it would be connected with the Little Falls inlier of Beekmantown and Precambric rocks, which is principally due to block tilting. While the West Canada creek inlier, as we may call it, appears at first glance as a simple and plain case of corrasion inlier, the facts that the river there flows parallel to the edge of the Precambric boundary of the Adirondacks and that the rocks dip away from this old land or towards the southwest, indicate the possibility of a more complex origin of this inlier. While it might be assumed that since the dip is very small (but 2° according to Cushing), it must be easy for the rapidly descending river to overcome the small southern component of this dip and to reach the Beekmantown beds, the fact that the Precambric rocks appear within the Beekmantown beds may indicate that both Precambric and superjacent Beekmantown rocks formed here an old prominence below the Trenton, which has been cut into in this inlier.

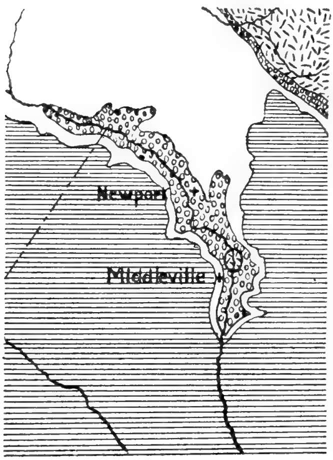


FIG. 11 Inlier of Beekmantown limestone [legend symbol] in Trenton limestone [legend symbol] along West Canada creek, N.Y. Scale 7.5 m. = 1 in.

A plainer and simpler case of an erosion inlier is furnished on the Penn Yan-Hammondsport sheet of New York,[1] where an iso-

[1] Luther, D. D. N. Y. State Mus. Bul. 101. 1906.

lated patch, about 4 miles long, of Neodevonic West Hill sandstones and shales appears in the deep valley of Meads creek below Monterey, from below the overlying High Point sandstone, and

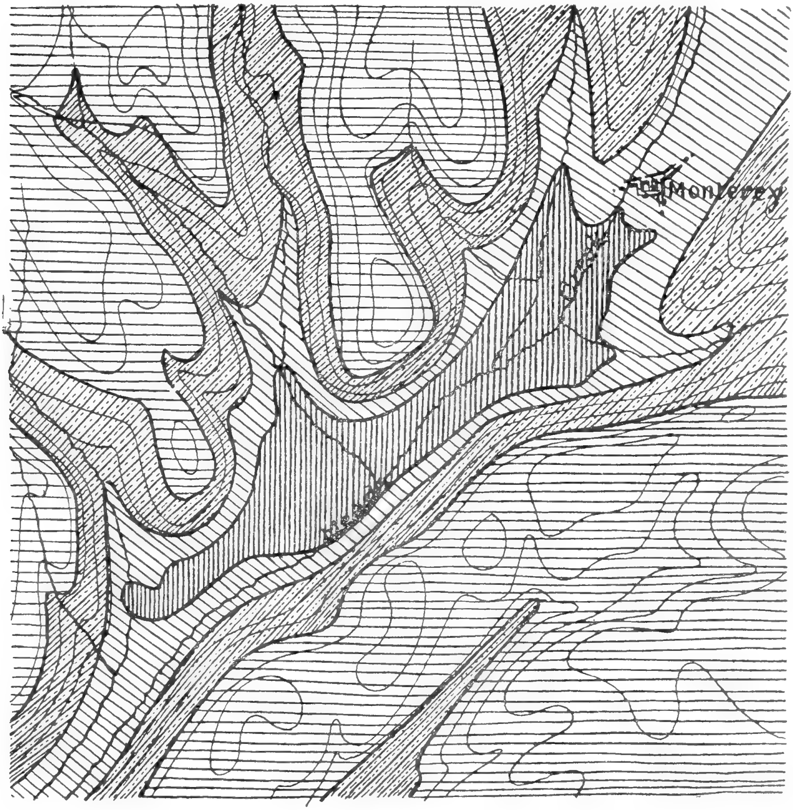


FIG. 12 Inlier of West Hill sandstone in High Point sandstone and superjacent beds, below Monterey, N. Y. Scale 1 m. = 1 in.

is surrounded by all the following beds of the series up to and including the Chemung sandstones and shales [*see* text fig. 12]. It is apparent that here the gradient of the creek is locally greater than the southwestern component of the southern dip of the rocks.

The last two instances seem to indicate that it is not necessary that the dip and course of a brook coincide for the formation of an inlier, as long as the gradient of the brook becomes greater than the component of the dip of the rocks that runs in the direction of its course.

It would not seem probable that inlier resulting from different

steepness of gradient of river course and dip of rocks, where the two are equally directed, should assume large proportions since this would presuppose but a slight difference of steepness in the two and a like direction over a long distance. Nevertheless the geologic maps reveal such large inliers. An especially clear example seems to be that of the inliers on the coastal plain of the Carolinas[1] [*see* text fig. 13]. There we see the Upper Cretaceous

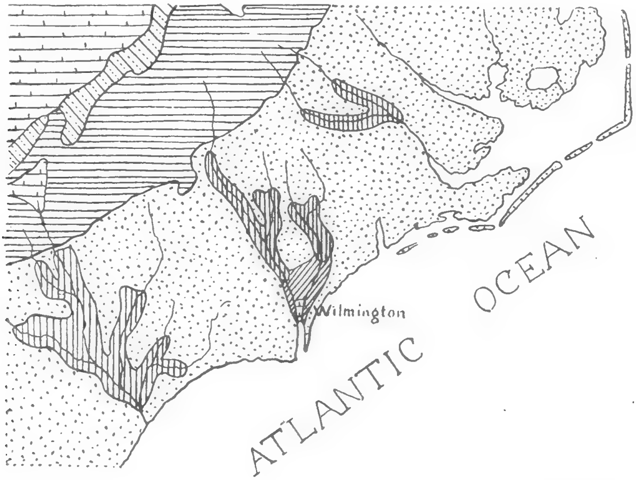


FIG. 13 Inliers of Upper Cretaceous in Neocene and Eocene in the Carolinas. Scale $\frac{1}{5000000}$.

appear in long tortuous strips, 70 miles and more in length, from under the Neogen along the Pedee river, the branches of Cape Fear river and Neuse river, in order to disappear again under tertiary beds above the mouths of these rivers. The relations of the strike of the tertiary and cretaceous formations and of the courses of the rivers to the coast line indicate that the dips and river courses are approximately coincident.

b Solution inliers. In some of the small inliers of Lowville limestone in the Black River limestone of the Watertown region, there is fair evidence that solution has played an important part in the removal of the overlying rock. This is especially the case in the inlier along Perch river below Limerick [*see* text fig. 14, 15]. The longitudinal section shows that the river plunges with a high fall from the Black River into the Lowville, upon whose hard bed it flows for half a mile in order to disappear above the "Natural Bridge" under the Black River limestone. Just to the south of the

[1] Willis, B. Carte Géologique del' Amérique du Nord. 1906.

Natural Bridge it reappears, flows a short distance upon Lowville beds and disappears again under Black River limestone, not to reappear for another half mile. This last half mile is the most important for the understanding of the process which produced the inlier farther up. The course of the river can here be followed through the woods by a distinct depression that is covered with large, variously tilted Black River slabs and partly bounded on the sides by Black River cliffs. It is here manifest that the Black River strata as a whole have been sinking down along the river as in a graben, being eaten away underneath by the dissolving water. Finally, the blocks become so small that freshets are able to remove them entirely and the river again flows in the open and on the underlying Lowville beds. While it is quite apparent that this and other inliers of the same kind wander upward, after they are started, by the waterfall at the upper end, the original cause of the phenomenon is quite clearly the water that along the joints, which are here strongly developed, passes between and under the Black River blocks until it reaches the harder and less soluble Lowville beds. The fall at the upper end is to all appearances a secondary development.

It is obvious that this group of inliers is essentially a Karst phenomenon and that these inliers correspond to the "Dolinen," so well known in the Karst plateau of Austria. We must, therefore, expect to find other examples in the limestone regions of the State. The Helderberg plateau presents a number of instances of depressions or sink holes in the limestones through which the underlying rocks appear. Most

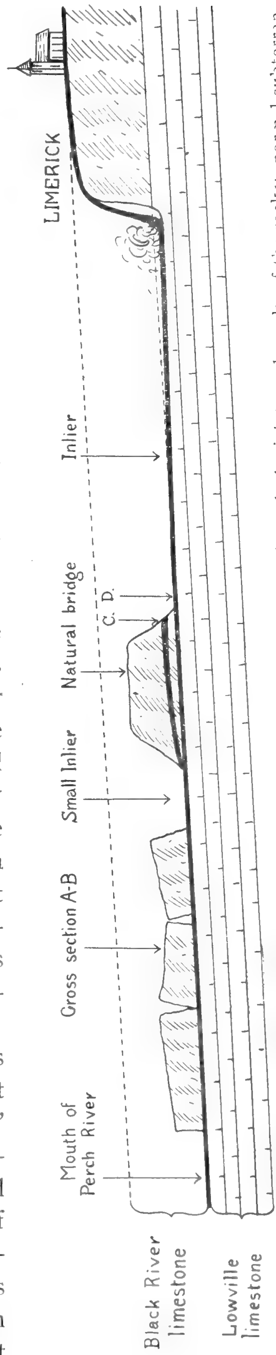


FIG. 14 Diagrammatic section of Perch River inliers: C, high water subterranean course through the joints and cracks of the rocks; normal subterranean course on the surface of the Lowville limestone

of them are too small to have been indicated on the preliminary maps, although there is no doubt that the mapping of the quadrangles will bring out a considerable number of them. One, a

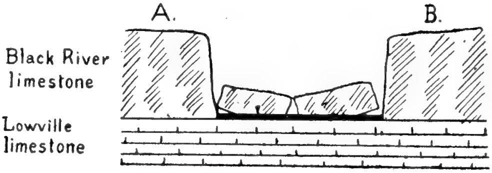


FIG. 15 Diagrammatic cross section of Perch river at AB in figure 14

quarter of a mile long, where the Esopus shale appears from under the Onondaga limestone, is shown on Darton's map of Albany county [N. Y. State Geol. Rep't for 1895] directly south of Clarksville.

Many such small inliers are also to be expected in the Salina beds, where the gypsum beds have been dissolved out. As an example that has found expression on the maps, we cite the exposure of Salina gypsum in the Salina (Bertie) waterlime north of Union Springs.[1] The gypsum beds form here a good horizon, which in several places is exposed from under the overlying Bertie waterlime, partly by natural erosion (sinking in of the surface through partial solution of the gypsum) and partly by quarrying.

There exists in the United States a region where large solution inliers are the most prominent physiographic feature of the country. This is where the Carboniferous limestones in Kentucky and Tennessee, through their great solubility, provide subterranean courses for the atmospheric waters. There the majority of the brooks disappear in sink holes. Frequently these sink holes grow into larger depressed areas, so called "sinks," and in some cases these depressed areas, arising from subterranean solution by the ground water, are square miles in size. They are then locally called "coves." In these "sinks" and "coves" the older formations are exposed as true inliers. We insert here a sketch [*see* text fig. 16-18] of a sink and of a cove taken from the Standingstone (Tenn.) Folio, which is used in Salisbury and Atwood's instructive paper, *The Interpretation of Typographic Maps*[2] to illustrate the effects of ground water. In this special case the Newman limestone forms inliers in the overlying Pennington shale.

[1] *See* N. Y. State Mus. Bul. 69. 1903. Map facing p. 1130.

[2] Salisbury, R. D. & Atwood, W. W. Professional Paper No. 60, U. S. Geol. Sur. 1908.

c Glacial erosion inliers. As inliers caused by glacial erosion we consider those cases where in the Finger Lake region an

FIG. 16 Sketch map of "Icy Cove" from Standingstone folio, Tenn. Scale $\frac{1}{62500}$

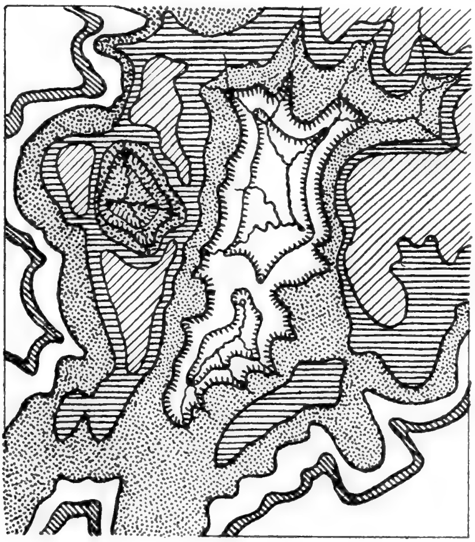


FIG. 17 Geologic map of "Icy Cove," showing the Newman limestone forming the bottom of the depression and the Pennington shale and following formations the walls

overdeepening of the valleys has taken place that leads to exposures of deeper beds surrounded by younger beds, a process ascribed by some glacialists to glacial erosion. While on account of the con-

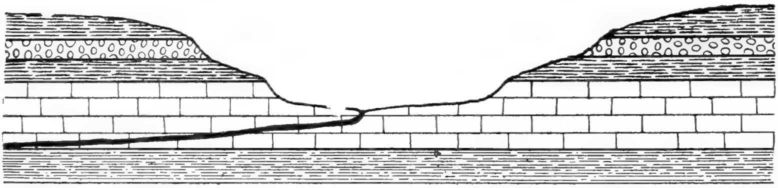


FIG. 18 Diagrammatic section of a "sink" or "cove", the black line indicating the subterranean water course

siderable depth of most of these lakes, there is no doubt that their bottoms reach down even into Siluric beds when their shores are in the Devonic, but the maps do not suggest this fact, except in a very few instances. One of these that appears quite convincing is the exposure of Middlesex black shale along the west branch of Keuka lake[1] and in the lower portion of the valley lying in the continuation of the lake [*see* text fig. 19]. This long outcrop of Middlesex shale is entirely isolated and surrounded by the overlying Neodevonic beds (Cashaqua shale, etc.) In this case it would seem that the north-south flowing brook, emptying at Branchport, and running with the dip of the rocks, found itself in the condition described above under corrasion inliers and thus might have alone been competent to produce a part of the inlier, although its short length and small size and the great length of the inlier and depth of lake basin indicating a great amount of erosion, are now entirely out of proportion and glacier ice is therefore to be appealed to as a factor, especially in regard to the inlier of the west branch of the lake.

We have thus far considered the inliers which originate from the agency of water, in either depositing or eroding. We now turn to the more important groups of inliers produced by diastrophism. These are the fold and fault inliers.

3 **Fold inliers.** These are formed *a* on the summits either of a_1 normal anticlines or a_2 domes ("uplifts," "parmas") or *b* through overturned folds ("Klippen").

We will first consider those very frequent cases of inliers of rocks, appearing on summits of normal folds through erosion.

[1] Luther, D. D. Penn Yan-Hammondsport Quadrangles, N. Y. State Mus. Bul. 101. 1906.

a Normal anticline inliers. In this group it will be advantageous to distinguish between the long bandlike inliers produced by long typical folds and the short elliptical inliers which result from the short pitching anticlines [brachyanticlines Lory, *see* E. Haug, Traité de Géologie, 1907. p. 204] with periclinal extremities. Examples of the first group are found in the folded region in the eastern part of the State where the long narrow strips of Lower Cambric, especially north of the Hoosic river, represent, according to the present conception of the structure of this region, more or less complex anticlines.[1] The Cambric is here surrounded or thought to protrude from Lower Siluric rocks. This conception is shown in Dale's section of the north end of the Taconic range. It is, however, possible that the relations of the Cambric to the Lower Siluric are greatly different in the slate belt and we will recur to this point under the heading of overthrust inliers [*see* p. 188]. To find undoubted macroanticlinal inliers we have to go outside of the State, to the northern extension of our folded regions, to Vermont, and to the Allegheny mountains. Here are long belts of Cambric rocks inclosed by the Lower Siluric areas and such of the

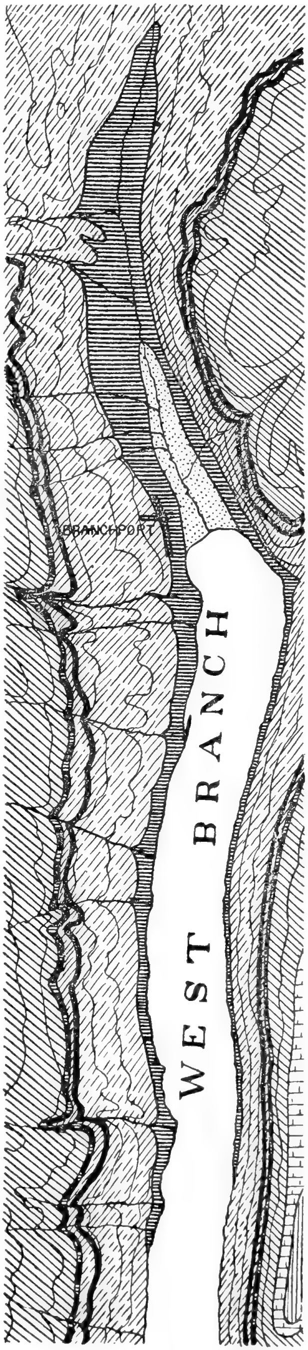


FIG. 19 Inlier of Middlesex black shale in Cashaqua shale and superjacent formations. Alluvium. 100 foot contours. Scale 1 m. = 1 in.

[1] *See* Dale. Am. Jour. Sci. 4 s. 1904. 17:185.

latter protruding from still younger rocks. But it is certain that not only the Cambric belts in eastern New York but also some of the large inliers of basal gneisses along the eastern boundary partake of the nature of folded or anticline inliers; this would seem to be especially clear in the case of the large inlier, beginning near Dover Plains (east of Poughkeepsie) and extending northeast along the Housatonic river. This is surrounded on the west and south sides by a belt of crystalline limestone. The Highlands themselves are a "horst" [*see* p. 186] as we shall see later.

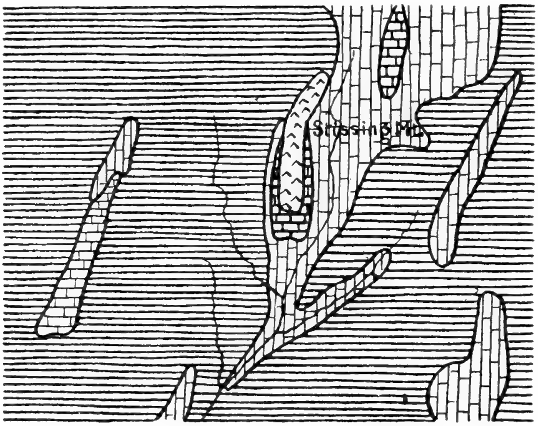


FIG. 20 Inlier of Precambric rocks in Georgian and Lower Siluric limestone and shale at Stissing mountain, N. Y. Scale 15 m. = 1 in.

Numerous short, pitching or brachyanticlines that form inliers, project from the Hudson River shale belt. One of the best examples of this group is Stissing mountain, northeast of Poughkeepsie [*see* text fig. 20]. It consists of an elliptic outcrop of gneiss, surrounded by a belt of Cambric rocks on all sides except the north, the whole projecting from the plateau of metamorphic Lower Siluric shales. This outcrop of gneiss is 20 miles away from the larger Housatonic inlier. It also distinguishes itself from the many smaller inliers of Cambric rocks in the neighborhood by the fact that it does not follow the northeast direction of the latter, but strikes due north. This indicates that this remarkable protrusion of gneiss through the thick belt of Cambric and Lower Siluric

rocks is probably due to a cross folding that combines with the normal fold, a frequent cause of brachyanticlines.

A nearly continuous line of small elliptic anticlinal inliers of Cambric rocks (mostly limestone), gneiss patches and Trenton

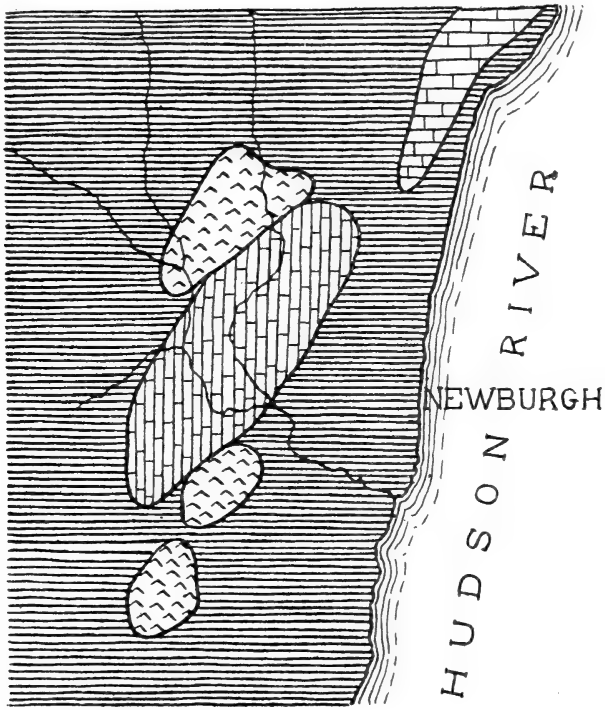


FIG. 21 Inliers of gneiss [legend] Georgian [legend] and Cambro-Siluric limestones [legend] in Lower Siluric shale [legend] at Newburgh, N. Y. Scale 5 m. = 1 in.

limestone extends in southwest direction from Stissing mountain toward and beyond Newburgh. In the close neighborhood of Newburgh there are no less than three small gneiss and one Cambric limestone inliers[1] [*see* text fig. 21], and a series of small inliers of gneisses and Cambric rocks extends thence along the north side of the Skunnemunk mountains. Ries gives four sections through one of these (Bull hill) which clearly show its composition of an open, normal anticline but also indicate that faulting may, to some extent, have influenced the production of some of these inliers.

[1] *See* Ries, H. N. Y. State Geologist's Rept. for 1895. 1:395.

Smaller anticline inliers may sometimes be also observed in the plateau regions of the central part of the State where a series of gentle folds representing further extension of the Appalachian mountain folding have been traced by Kindle.[1] Occasionally a small inlier will even bring out the presence of a fold in a region where there seem to be no indications of folding at all. Thus the writer observed a small Lowville limestone inlier coming up from Lake Ontario at Three Mile bay (Clayton quadrangle, N. Y.). This [*see* text fig. 9, inlier 1] follows first the brook, but about ¾ of a mile above its mouth, it leaves the brook and rises upon the hillside, ending just east of the Three Mile Bay railroad station. Here, in a quarry, the arch of the fold is exposed in the Lowville limestone beds, with the Black River on the flanks.

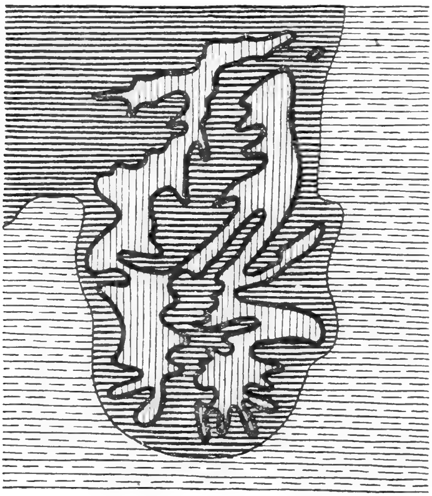


FIG. 22 Inlier on crest of arch on Pueblo folio, Col. Carlisle shale and sandstone Niobrara shale. Niobrara limestone. Scale $\frac{1}{125000}$

In the arid regions of the West, where neither drift nor alluvial deposits obscure the outlines of inliers, the intimate relations of inliers and folds are much clearer shown and forms of bizarre outline produced by atmospheric weathering. We insert, as an example [*see* text fig. 22, 23] taken almost at random, a sketch from the Pueblo folio, Col.

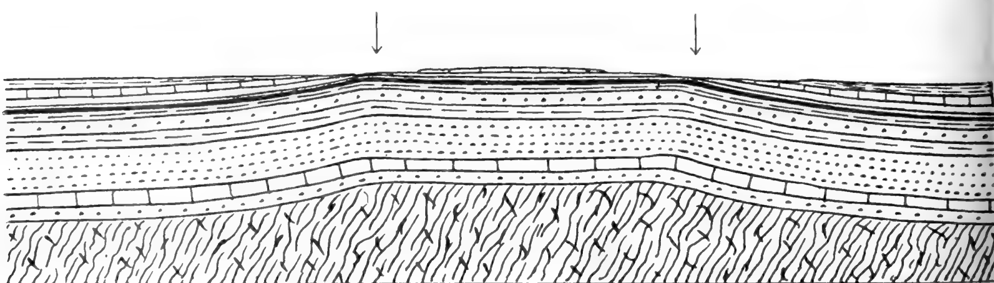


FIG. 23 Cross section of arch showing formation of inlier. Pueblo folio, Col.

[1] Kindle, E. M. Jour. Geol. 1904. v. XII, no. 4, p. 281. *See also* Luther, D. D. N. Y. State Mus. Bul. 128. Colored section.

[Geol. Atlas of the United States] of an inlier of Carlisle shale (Cretaceous, subdivision of the Benton formation) in the Niobrara formation (shale and limestone) on the crest of the Rock Canyon arch, a broad anticlinal fold. A few miles farther north the same arch produces at the crossing with the Kansas river an inlier where not less than three of the underlying formations are brought to view.

The last inlier mentioned which is caused by a low, broad and long anticline brings us to those anticlines which, being little longer than wide, are known as

a Uplifts, parmas and domes. The State of New York does not contain any of these structures. For this reason we cite only two instances of inliers arising from these structures, one representing the smaller domes, and one those of the first order.

Kindle[1] has described from northern Indiana, small outcrops (about a quarter of a mile is the diameter of one given) of Niagara limestone which form dome-shaped elevations, possessing quaquaversal dips and are surrounded and partly covered by Devonian shales, thus forming inliers of Niagara beds in Devonic rocks. These domes are considered by Kindle as analogous to the "mud-lumps" at the mouth of the Mississippi. They formed islands during a large part of the early Devonic and were then covered by the Devonic Black shale, thus corresponding in their origin partly to our first group of deposition inliers, with the difference, however, that the prominences of the sea bottom in that group were thought to result merely from erosion.

Domes of the first order are in this country typically represented by the Cincinnati and Nashville "uplifts" [*see* text fig. 24], which have been termed *domes, uplifts,* a *geanticline* by Dana and designated as a "*parma*" by Suess. This broad and low anticline, which is a secondary phenomenon in the great Paleozoic mediterranean basin played an important rôle during Paleozoic time in separating minor basins. It is now recognized by the fact that the Lower Siluric forms two extensive inliers, a northern one, the Cincinnati uplift on both sides of the middle course of the Ohio, a southern one, the Nashville uplift in Tennessee. The latter presents in the long, pinnate offshoots along the Cumberland and Tennessee rivers, excellent examples of the paramount influence of corrasion in finally exposing the deeper beds.

4 **Fault inliers.** Inliers are produced on the upthrow side of faults. Two groups can be distinguished in this class, (*a*) those

[1] Kindle, E. M. Am. Jour. Sci. 1903. 15:459.

that are bounded by one fault and (*b*) those that lie between two faults (horst). We have good examples of both kinds in this State, at the hand of which we will note their general characters.

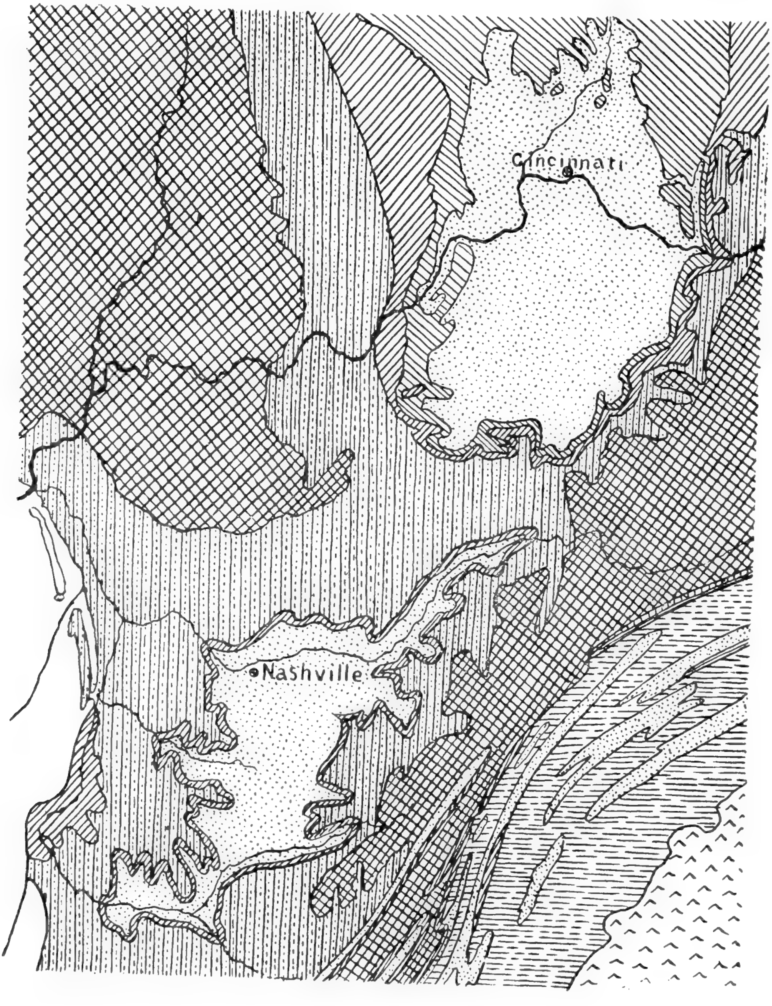


FIG. 24 Ohio basin with the Cincinnatti and Nashville inliers. Lower Siluric; Upper Siluric; Devonic; Mississippian; Pennsylvanian. Scale $\frac{1}{5000000}$

The best ones are furnished by the Mohawk valley, which is crossed by a system of northeast striking faults, mostly with the

downthrow side on the east.[1] Consequently there protrude patches of Precambric rocks, as at Sprakers, Little Falls, and the "Gulf" (north of Little Falls), or of Beekmantown and Trenton from the Utica shales [*see* text fig. 25, 26]. Several of these are involved with a second fault, and will be mentioned under the next group; others, however, as the Beekmantown inlier at Tribes Hill, at Fonda Bush, the Precambric inlier at Sprakers, that at the Gulf and the western portion of the Precambric inlier at Little

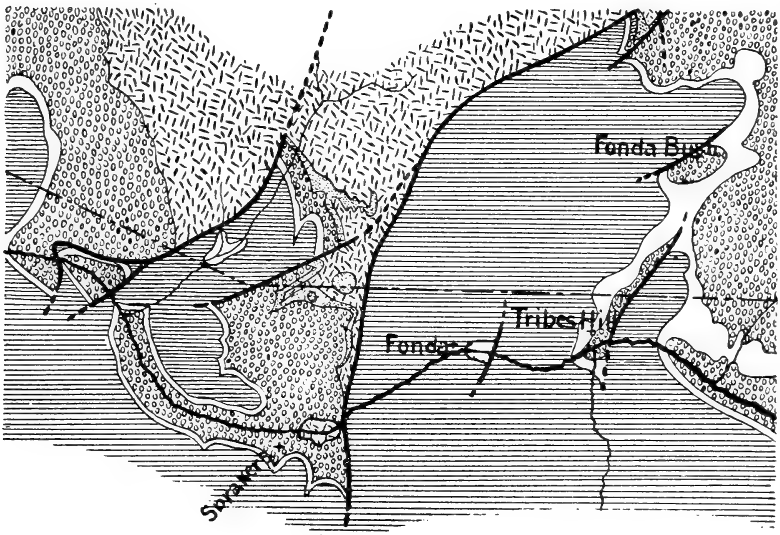


FIG. 25 Sketch map of the faulted region of the Mohawk river in eastern Fulton county, N. Y. showing the inliers at Sprakers, Fonda, Tribes Hill and Fonda Bush. Precambric rocks; Potsdam sandstone; Beekmantown limestone; Trenton limestone; Utica shale. Scale 7.5 m. = 1 in.

Falls are, according to the sections furnished by Darton and Cushing, brought up by the tilting of the blocks along one fault plain. Corrasion has in all these cases served as an accessory agent in exposing the deeper rocks. Where least disturbed by corrasion, they are readily recognized by their outline, which consists of a straight line along the fault and as a rule of a more or less curved boundary on the other side, the whole inlier approaching a segment in form. The areas of Paleozoic sedimentaries on the west side of Lake Champlain which also are broken up into vari-

[1] *See* Darton, N. H. N. Y. State Geol. Rep't for 1894. 1895. p. 30.

ously tilted fault blocks will no doubt furnish other examples of these inliers when fully mapped. Likewise the folded region on the east side of the Hudson and in Orange county contains inliers whose principal cause is faulting, but all of these are also more or less involved in folding.

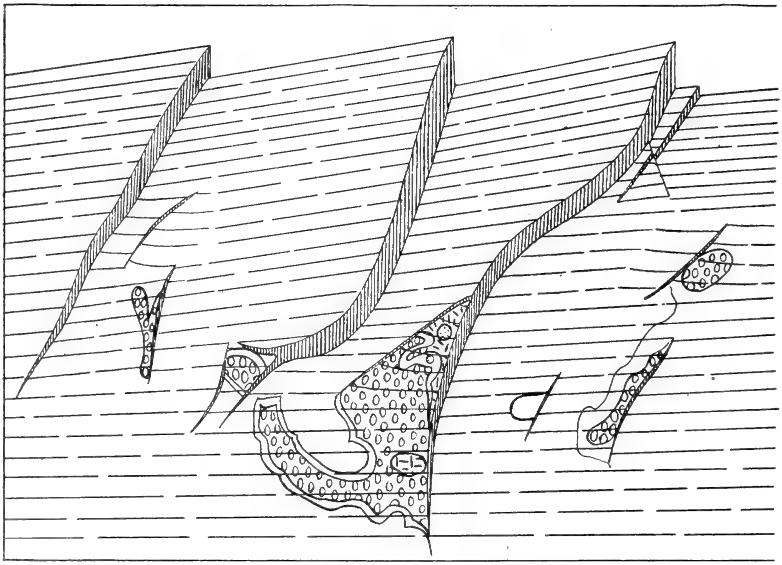


FIG. 26 Diagram of faulted and tilted blocks in eastern Fulton county, N. Y. (after Darton). Looking north; showing relations of inliers of text figure 25 to faults

Where a block has remained standing between two faults inclining away from each other, a horst is produced. This group of inliers has typically the form of a parallelogram or of a rectangle. The greater portion of the Precambric inlier at Little Falls, that to the east of the town, partakes of the nature of a horst by being included between two parallel faults of opposite throw, as shown by Cushing [*see* text fig. 27, 28].

As a horst of the first order in this State, we have probably to consider the large inlier of gneisses and associated rocks of the Highlands, since Berkey[1] has shown that this block is bounded by two parallel faults between Cornwall and Peekskill. It is stated by Berkey [*loc. cit.* p. 374] that the northern fault consists rather of a succession of them, "each separate fault line striking out toward the northeast into the bounding slates and its place

[1] Berkey, C. P. N. Y. State Mus. Bul. 107. 1907.

taken by another nearer the margin." This seems to indicate that the breaking down of the flanks has taken place in steps as in the

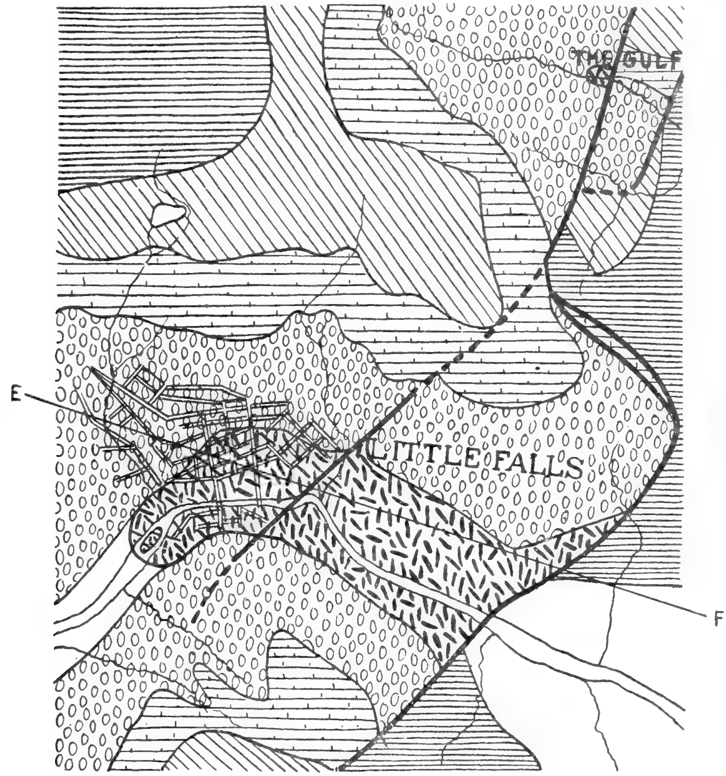


FIG. 27 Inlier of Precambric rocks in Beekmantown limestone; Utica shale. Scale 1 m. = 1 in. Trenton limestone; Dolgeville beds;

typical horsts of Europe. In one of the northern faults the fault plane has been observed [p. 775], and it was found to dip steeply to the southeast making it a reversed fault, or overthrust.

FIG. 28 Section through inlier at Little Falls (after Cushing)

As the section through a part of the Highlands by Professor Berkey shows, the great fault on the other (southern) side hades in the same direction. This large fault block is hence bounded by

two systems of parallel faults that both hade in the same direction (southeast). It might therefore be considered to be more of the character of an overthrust wedge [*see* below] than of the horst, in which, when typically developed, the faults incline away from each other. It is, however, apparent that in the general sense of a horst, as now understood in Europe, as a fault block that is on the upthrow side with reference to all the area around it [*see* text fig. 29], the Highlands fulfill all conditions of this type of structure.

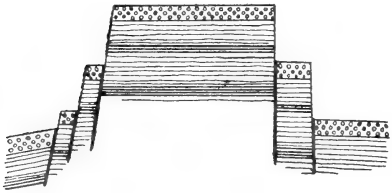


FIG. 29 A horst (after Haug)

c Branching fault inliers. A small division of raised blocks, appearing as inliers is formed by *branching faults,* where a triangular block remains standing between the branches. The Mohawk valley furnishes again a few good examples of this group [*see* text fig. 25] of inliers, that are mostly recognized by their subtriangular outline. Below St Johnsville we find a triangular outlier of Beekmantown with a surrounding band of Trenton emerging from the Utica shale, and the Noses fault (below Sprakers) with its branch, the Ephratah branch fault, forms another triangular Beekmantown inlier.

d Wedge inliers. As wedge inliers or "wedges" we designate here inliers that are found between two overthrusts. There is no doubt that many such wedges exist in our eastern, much overthrust slate belt, but the close isoclinal folding of the belt obscures the faulted structure there to such an extent, that it is preferable to select typical examples from less disturbed areas. The Appalachians furnish many clear cases of this structure, of which we select, on account of the great difference in age of the adjoining rocks, one from the Briceville folio, Tenn. [Geol. Atlas of the United States, 1896]. It will be seen in the section [*see* text fig. 30] that five overthrust faults are there recognizable between them containing three wedges of Siluric rocks, which on the surface form narrow, bandlike inliers in Carboniferous rocks, sometimes flanked by a narrow strip of Devonic rocks.

e Overthrust inliers. We designate as overthrust inliers those which result from the extensive transportation of older rocks over younger ones along more or less horizontal thrust planes, resulting from overturned anticlines ("fold thrusts" of Willis) and from

"surface thrusts" (Willis). As an example we insert a portion [text fig. 31] of the Rome (Ga.) folio, showing inliers of Cambric

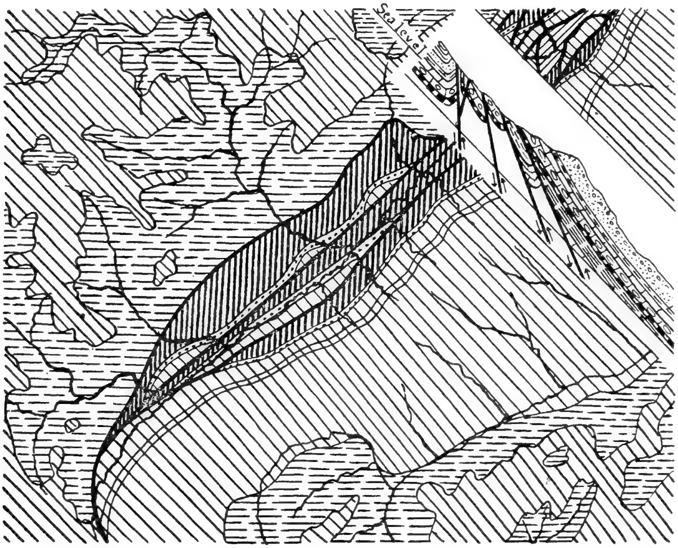


FIG. 30 Wedge inlier from Briceville folio, Tenn. Siluric (Rockwood formation); Devonic (Chatanooga shale); Carboniferous (Lee conglomerate); Carboniferous (Briceville shale). Scale $\frac{1}{125000}$

rocks in Carboniferous beds, appearing as small synclines, but which in fact, as shown by the section are but the erosion remnants of a huge, closely folded overthrust plate of the kind that has been so much discussed in late years by the Alpine geologists [their "Ueberschiebungen" or "charriages," *see* text fig. 32].

It is possible that the slate belt of eastern New York represents such an overthrust region of the first order. We see the strongest arguments for this view in the long fault that separates the Lower Siluric and Cambric rocks east of the Hudson which is known to be an overthrust fault; and in the fact that in several places, as most clearly near Whitehall, the littoral facies of the Cambric and Lower Siluric (Potsdam sandstone, Beekmantown dolomite and Trenton limestone) and the graptolite-bearing shale facies of the same formations come into contact, which implies — granted the original separation of the two facies by either a barrier or differences of depth — an extensive westward transportation of the shales. If

one further considers that the former series, at that locality, is fully undisturbed and the other abruptly folded in closely packed

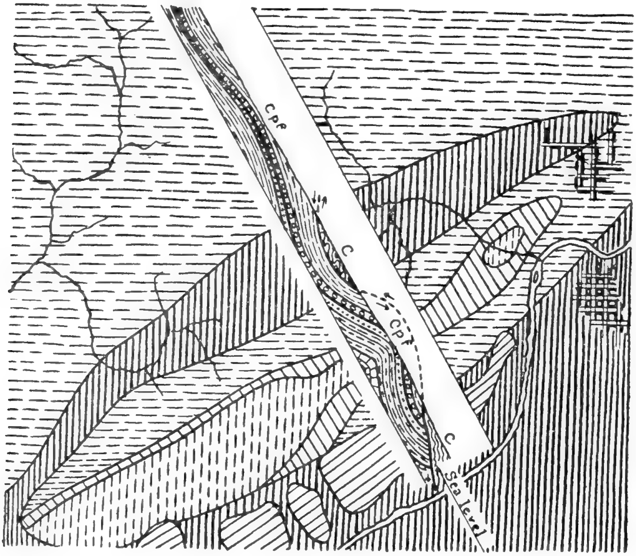


FIG. 31 Shows formation of inliers by overthrusts. From Rome quadrangle (Ga.—Ala.). (C in section) Cambric (Conasarga formation); Carboniferous (Floyd shale). Scale $\frac{1}{125000}$

anticlines, it must be inferred that the folded mass has, as a whole, been pushed upon the first series to an unknown extent. Dr Ulrich with whom I had the pleasure of discussing this view during our summer trips into the Champlain region, reached independently a like view, finding positive evidence of such a great charriage in the conditions surrounding the

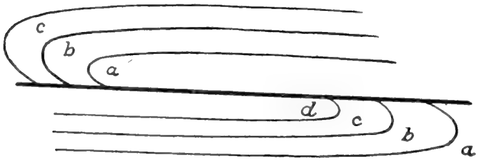


FIG. 32 Charriage (after Haug)

north end of the Taconic mountains, where a small "outlier" of Stockbridge limestone appears in the Cambric rocks and belts of "Hudson slate" accompanying the Cambric inlier [*see* text fig. 33] on the west. It is there quite probable that the whole

folded plate of Cambric rocks has been pushed along a slightly inclined fault plain from the east over the Lower Siluric rocks, and that the outlier of Stockbridge limestone does not rest in

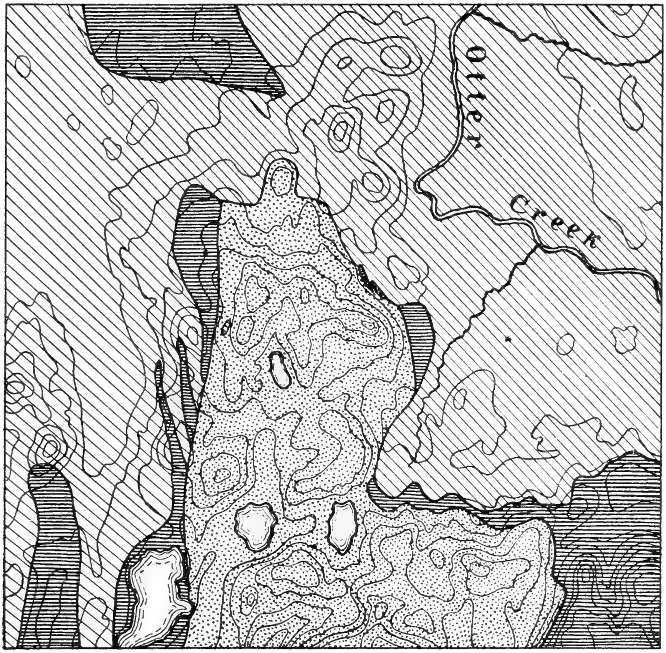


FIG. 33 North end of Taconic range (copy from Dale).

Lower Cambric slate; Stockbridge limestone; "Hudson" slate

a small syncline of the Cambric, as it would seem, but protrudes from below the Cambric or is a "Fenster," as the European geologists term it (an outlier of younger rock protruding through older rock in consequence of extensive overthrust and partial weathering away of the overthrusted mass). We have attempted in Museum bulletin 42 [1901. p. 556] to indicate this condition for the Albany region. If we assume this overthrust to have still more approached the horizontal and the transportation along the thrust plane to have been quite extensive, we get conditions which seem to explain many of the greater phenomena of the slate belt. We insert here a section, given by Dale, from the neighborhood of Schodack Landing, south

of Albany, showing well the overthrust of the Cambric rocks over the Lower Siluric [text fig. 34].

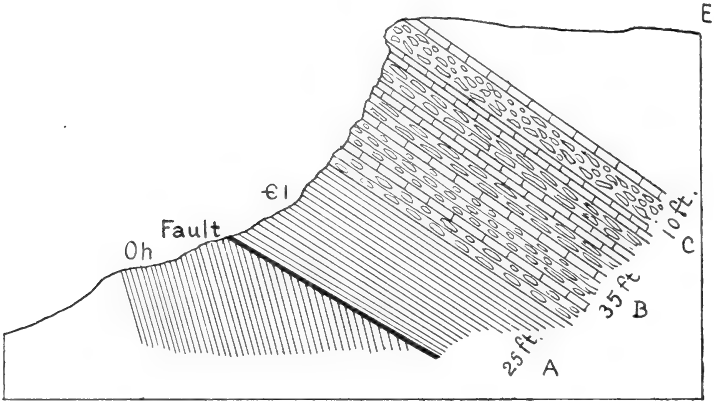


Fig. 34 Diagram section showing the relation of the Lower Cambric limestone (B, C) and shale (A) to the Hudson shale (Oh) as exposed at the localities near Schodack Landing in Rensselaer county. (Copy from Dale)

We also refer in this connection to the section from the Rome (Ga.) folio, inserted here as example of overthrust inliers, as showing that extensive overthrusts of like character as the one here assumed are actually known to occur in the southern Appalachians.

If Dr Ulrich's and the writer's conception of the structure of the slate belt is correct, the belts of "Hudson slate" between the Stockbridge limestone and the Cambric at the north end of the Taconic mountains are most probably wedges between thrust faults.

There have been distinguished, altogether, 14 kinds of inliers in this essay, which are of very different importance. They may be grouped as follows:

A Caused by action of water

1 *Deposition inliers,* resulting from burying by newer strata of
- *a* original outliers
- *b* erosional irregularities of surface
- *c* lenses and reefs

2 *Erosion inliers,* comprising those resulting from
- *a* corrasion — corrasion inliers
- *b* solution — "sinks" and "coves"
- *c* glacial erosion — glacial erosion inliers

B Caused by diastrophism

3 *Fold inliers,* formed
- *a* on the summits of anticlines
  - a_1 on macroanticlines — normal anticline inliers
  - a_2 on brachyanticlines — brachyanticline inliers
  - a_3 domes — uplifts, geanticlines, parmas
- *b* through overturned folds (klippen)

4 *Fault inliers,* formed
- *a* on upthrow side of single faults — segment inliers
- *b* on upthrow side of double faults — horsts
- *c* between branching faults — branching fault inliers
- *d* between overthrust faults — wedge inliers
- *e* through extensive overthrust — overthrust inliers

SOME MARINE ALGAE FROM THE TRENTON LIMESTONE OF NEW YORK

BY R. RUEDEMANN

The early paleontologists described as algae all fossil bodies from the marine beds which in their habit had some similarity to plants, whether or not any organic structure or substance was shown, and in so doing created a burdensome mass of names. The tendency of late has been to doubt the vegetable nature of all so called Paleozoic seaweeds; or to follow Nathorst[1] who, after proving the mechanic or animal origin of many of them, makes the presence of a rind of coal the ultimate criterion. Solms-Laubach,[2] however, will not admit this, since "the coal may entirely disappear in the course of time from remains that are undoubtedly organic, if they are deposited in a porous rock."

The actual presence of fossil algae in at least one of the Paleozoic formations of New York, viz the Chemung, was demonstrated a few years ago by David White.[3] It is pointed out by this eminent paleobotanist that plant life of the class Algae must have been very abundant in the Siluric and Devonic eras and that the apparent rarity of undoubted Paleozoic seaweeds is due to several causes one of which is here cited as having a direct bearing on the material in hand and the discussion to follow. This is the partial explanation of the apparent rarity, resting "in the remarkable similarities in form and habit between many algae and certain contemporaneous low animal types, specially among the sponges and sertularians, whose structure was so much better suited to preservation as to establish a presumptive hypothesis that the resemblant forms must embrace the animal characters of structure and would not have been preserved but for the presence of the latter."

A reaction from the tendency to refer the distinctly preserved algoid remains to the animal rather than to the vegetable kingdom may be said to have set in in the last decade of the preceding century. It is denoted by investigations of Rothpletz, Alexander Brown, Stolley and Whitfield. The first named author[4] began by referring to the algae, Girvanella problematica Nichol-

[1] Nathorst, A. G. Kongl. Svenska Akad. Handl. 1881. v. 18, n. 7.

[2] H. Graf zu Solms-Laubach. Fossil Botany. 1891. p. 47.

[3] White, David. N. Y. State Mus. Bul. 52. 1902. p. 593.

[4] Aug. Rothpletz: Fossile Kalkalgen aus den Familien der Codiaceen und der Corallineen. Zeitschr. d. deutsch. geol. Ges. 43 Bd. 1891. p. 295.

son and Etheridge from the Lower Siluric of Ayrshire, England, placing it with some doubt among the Codiaceae to which he also referred the Mesozoic Sphaerocodium. Both Girvanella and Sphaerocodium form compact bodies essentially composed of an intricate mass of fine continuous tubes. Alexander Brown next took up the problem of the taxonomic position of Solenopora,[1] a genus that in Solenopora compacta (Billings), its genotype, is well represented in the Lower Siluric of New York, and discovered its cellular structure (a tubular one was assumed before), finding that its cells bear great similarity to those of certain living and fossil coralline algae and that there are also traces of tetrasporangia and conceptacles corresponding to those of the recent Corallineae, to which he therefore refers Solenopora as a possible ancestor of the recent nullipores.[2]

E. Stolley[3] in 1893 demonstrated the presence of indubitable calcareous algae in boulders of northern Germany derived from the Lower Siluric of Sweden and described a number of forms which exhibit relationship to the recent Bornetella and the triassic Gyroporella, and all of which were undoubtedly verticillate Siphoneae except one (Arthroporella catenularia) which consists of chains of spheric and pear-shaped bodies and is compared with the Eocene Ovulites.

Finally, Whitfield[4] placed a form hitherto referred to the graptolites (Bythograptus laxus) among the algae, principally for the reason that the secondary branches are connected by distinct articulations with the central stipe and that proper cell apertures are absent or indistinguishable.

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[1] Brown, Alexander. On the Structure and Affinities of the Genus Solenopora. Geol. Mag. IV. 1894. p. 145.

[2] Professor Rothpletz has lately published the results of his most thorough and painstaking investigations of these difficult and problematic forms [*see* Ueber Algen und Hydrozoen im Silur von Gotland und Oesel, in Kongl. Svenska Vetensk. Handl. Bd. 43, no. 5, 1908] positively placing Girvanella problematica, and Sphaerocodium, to which also a Siluric form is referred, as well as Solenopora, among the algae. As most important for the taxonomic position of Solenopora, he considers the presence of perforations of the cell walls discovered by him, the arrangement of the concentric rows of cells and the similarity of the tubular, isolated sporangia in Solenopora gotlandica and the Archaeolithothamnia.

In a review by Steinmann (Zeitschr. für Induktive Abstammungs-und Vererbungslehre, Bd. 1, Hft. 4, p. 405, 1909) that has just come to hand the existence of probable transitional forms (in the Permian limestones of Sicily and the Jurassic) between the Siluric Solenopora and Lithothamnium, that begins in the Cretaceous period, is pointed out.

[3] Ueber silurische Siphoneen. Neues Jahrbuch 1893. 2:135.

[4] Whitfield, R. P. On New Forms of Marine Algae from the Trenton Limestone, with Observations on Bythograptus laxus Hall. Bul. Am. Mus. Nat. Hist. 1894. v. 6, art. 16, p. 351.

Bythograptus laxus comes from the Trenton limestone of Platteville, Wis. The same locality has furnished a small number of other forms of vegetable aspect, which are also described on good ground as marine algae in the same publication.

In a later paper[1] Professor Whitfield created a new genus *Palaeodictyota,* for a form from the Niagaran of New York before described as a graptolite (Inocaulis anastomotica Ringueberg) believing the same to be a marine alga. The present writer has lately [N. Y. State Mus. Mem. 11. 1908. p. 20] shown that *Palaeodictyota* has the tubular composition and the cell apertures of a graptolite of the order Dendroidea.

These facts serve to show that there is a group of graptolites that in their habitus approach so much that of the seaweeds that since the time when Goeppert referred *Dictyonema* to the fucoids announcing the discovery of a fructification (cystocarp) like that of *Callithamnion* on its branches, botanists have still thought it possible they might be plant remains, and *Dictyonema* is still cited in the great standard systematic work, Engler-Prantl's "Die natürlichen Pflanzenfamilien" [1 Teil, 2. Abt. 1897. p. 554] among the doubtful seaweeds.

While searching for graptolites in the Trenton limestone of Glens Falls, N. Y., the writer has discovered a congeries of like character with that from the Trenton group of Platteville, Wis. It is rather with the intention of recording the occurrence of this rare group of fossils in the eastern Trenton than for the purpose of discussing the problem of the vegetable or animal character of these fossils that this note is published. We also insert for this reason a form from Glens Falls that gives fair evidence of being a graptolite of the order Dendroidea but has also a vegetable appearance and is associated with the others, and we desire to state in this connection our belief that the evidence in every single case has to be weighed separately.

The small assemblage of Trenton fossils at Glens Falls was found in thin patchy seams of very fine grained black shale intercalated in the shaly limestone forming the hanging wall of the abandoned "Black marble" quarries on the south side of the Hudson river. The layer containing the fossils is about 16 feet above the base of the Trenton.

Besides the algal remains the bed has been found during this investigation to contain also small fragments of true graptolites of

[1] Bull. Am. Mus. Nat. Hist. 16, art. 36, p. 399 (1902).

the genera Climacograptus, Cryptograptus etc. On account of the great interest which this graptolite occurrence has in regard to a possible correlation by intercalation of the corresponding graptolite horizon with the limestone series of the Trenton, this faunule will be studied separately after more extensive collecting.

The fact of the occurrence of graptolites proper together with the supposed marine algae may seem suggestive of the graptolite nature of all the fossils, especially if it is taken in account that some of the algoid forms exhibit in the carbonaceous films they have left, the distinctness and sharpness of graptolite remains in spite of their subdivision into hair-fine branches. On the other hand it could be urged that from the well recognized evidence of the growth of many graptolites on seaweeds the concurrence of the two in the same bed is a logical corollary. But, if the surrounding conditions at Glens Falls are taken into account, it becomes evident that the graptolites and the algoid fossils belong to different marine life zones. The very irregular surface of the thin bedded limestone and the patchy distribution of the black shale in depressions of the limestone, indicate that the deposition took place in rather turbulent water. The comminuted condition of the true graptolites shows that they drifted in from the open sea, while the fine preservation of the much more delicate algalike remains indicates that they grew where they are found and were sessile forms of the littoral zone.

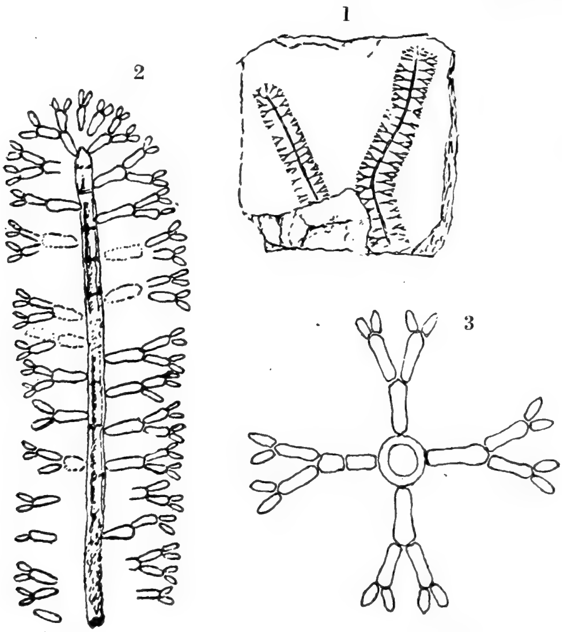
Dr Hovey has had the kindness to send me the types of two of the species of marine algae described by Professor Whitfield, for comparison and study. The structural details of these — presently to be described — leave no doubt of their vegetable origin. One is a distinct coralline alga from the Trenton of Middleville, N. Y. [*see* pl. 1, fig. 1], the other (Callithamnopsis fruticosa) a seaweed from the Trenton of Platteville, Wis. The latter is so closely related to one of the Glens Falls forms (C. delicatula) that by inference the latter must also be an alga although its structural features are not as distinctly seen. We will for this reason first note these two longer known species of manifest algal character and then attempt to demonstrate the vegetable nature of the Glens Falls forms by reference to them.

Primicorallina Whitfield

This genus of calcareous algae was erected for a single species, P. trentonensis Whitfield, from the Trenton limestone of Middleville. The form is described by its author as follows: "(The

specimens) consist of a central or longitudinal axis which is hollow and jointed, and of whorls of lateral branches of pinnules, apparently four, possibly five in number, radiating from the central axis and forming a cylindrical body in the aggregate. The pinnules of the whorls are composed of three elements each; a first joint which diverges from the central axis gives origin to two secondary joints, while each of these supports two still smaller joints or pinnulae." [1]

We insert here three of the original accurate figures by the author of the genus [text fig. 1–3] and add a camera drawing of one



Primicorallina trentonensis Whitfield

FIG. 1 Slab with specimens. Nat. size
FIG. 2 Type, x 4
FIG. 3 Transverse section. (Copies from Whitfield)

of the type specimens [*see* pl. 1, fig. 1], to bring out a few characters not noted in the original description.

[1] The following is the original description of the genotype: "Fronds of small size, represented by cylindrical tufts of greater or less length, and of from one sixth to one fourth of an inch in diameter. Axis of the frond irregularly cylindrical and jointed; the joints count about 30 to the inch and are nearly twice as long as thick. Pinnules four, or perhaps five, from each joint of the axis, composed of cylindrical, oval or clavate joints; those originating on the axis are of nearly an equal length with the axial joints, and each supports two others on the outer end of very nearly or somewhat shorter length, but of less thickness; these again each support two others which are short oval in outline and of not more than half the length of the others. Bifurcations of the pinnules diverging at an angle of about 30 to 35 degrees to each other."

A thick calcareous incrustation is found between the axial canal formerly occupied by the axial cell, or cells, and a thin, carbonaceous outer film. The axial canal becomes visible in the principal branch of the thallus where the tube is crushed [*see* pl. 1, fig. 1] and also an axial canal of the branchlets can be seen in the same specimen on the right-hand side. The calcium carbonate of the fossil contrasts by its dark brown and sometimes amber color with that of the matrix and of other fossils indicating a certain amount of carbonaceous matter still contained in it. In thin sections made through a few joints a deep black thin layer was seen on the outside and a less distinct one lining the axial canal, showing that the calcareous deposition took place within an outer membrane or gelatinous sheath. The outer black layer fails to show traces of former pores and the calcareous deposition is crystalline and devoid of structure.

Professor Whitfield describes the branchlets or pinnules as repeatedly bifurcating. The fact, however, that this bifurcation is seen in both the longitudinal and transverse sections of the same specimen suggests that also in the branchlets the division took place in double dichotomies or in whorls of four branches; and in fact in one place [*see* pl. 1, fig. 1 at a and b] three branchlets are seen at the second division (at a) and in one three at the third (at b). The thallus is hence composed of a system of verticils of branches. The joints of the main stem are cylindrical, little contracted at the articulations, those of the branchlets, however, are clavate, somewhat bulbous at the distal end and with rounded extremities. The terminal branchlets are pyriform, distinctly pointed at the distal extremity and round and bulbous at the other.

Thin sections through the few fragments of joints of the main stem and branchlets have not furnished any indication of the presence of cavities suggestive of conceptacles. The fructifications may have consisted of terminal sporangia that were easily detachable and were lost, or we may have only sterile thalli before us, or again, the terminal pyriform branchlets may have contained the conceptacles at their apexes and these may have become obscured by secondary crystallization. It probably will require more material than is available now to discover the fertile branches.

Professor Whitfield referred this form to the coralline algae (Corallinaceae), as shown by the name, probably on good ground as long as the verticillate arrangement of the branchlets of the second and third orders was not recognized. A verticillate

arrangement throughout the whole thallus such as this form possesses is, however, not observed among the coralline algae which for the most part possess only a flat, incrusting thallus and in the erect forms, as in Corallina, are bifurcating or irregularly branching, mostly in but one plane. The habitus of Primicorallina as restored in this publication [*see* pl. 1, fig. 2], is distinctly that of one of the verticillate Siphoneae and well comparable to that of Dasycladus or Polyphysa and other genera of the Dasycladaceae. Since calcification takes place also in several of the genera of this order of algae, and other calcareous verticillate Siphoneae were already abundant in the Lower Siluric seas, as shown by Stolley, it is preferable to place Primicorallina with the verticillate Siphoneae.

A reference of Primicorallina to the Dasycladaceae invites comparison to the other verticillate Siphoneae described by Stolley from the Swedish Lower Siluric. The latter forms differ in having the branchlets incrusted like the recent calcareous genera of Dasycladaceae (Cymopolia, Bornetella and Neomeris), to such an extent that a solid cylindric mantle is formed in which the branchlets are imbedded. In Primicorallina the incrustation of the axial cell and of the branchlets is comparatively slight, so that all the branchlets remain free. This is obviously only a difference in grade of calcification. Another difference rests seemingly in the segmentation of the stem which suggests a composition of the stem of more than one cell while in the verticillate Siphoneae it consists of but one, the axial cell. But it is here to be remembered that on one hand the axial canal in Primicorallina shows no or but little contraction (as far as can be seen from the few type specimens without breaking them) at the articulations and may well result from a single axial cell and that, on the other hand, an articulation of the whole thallus without subdivision of the axial cell exists also in the recent Cymopolia.

From Arthroporella Stolley, which consists of a chain of spheric and pear-shaped bodies such as the branchlets of Primicorallina might also form when seen in sections, the latter genus differs in having these bodies articulate while in Arthroporella the incrustation is continuous and is also distinctly porous.

It is very probable that Primicorallina has not only interest as one of the earliest known calcareous verticillate Siphoneae but that it is also of importance in explaining the origin of certain Trenton limestones of granular and oolitic texture. Small grains which

are the separate joints of this form fill the otherwise fine grained limestone containing the type specimens. It is therefore obvious that accumulations of these joints are competent to form a peculiarly granular limestone that may at times appear to be made up of comminuted crinoidal fragments and again as of undistinctly oolitic structure. The writer has collected a specimen of limestone at Glens Falls that entirely consists of just such granules which in a few places still retain their original serial arrangement and which, in spite of the obscuration of their structure by secondary processes, quite certainly are derived from calcareous algae. Stolley has already pointed out that the Siphoneae attained not only a high development in Siluric time but that they also grew in great abundance and that they will be found to have formed many limestones in that era. If Solenopora is a Coralline alga, then also that family of algae must have contributed largely to the formation of our Trenton limestone by the var. trentonensis of Solenopora compacta.

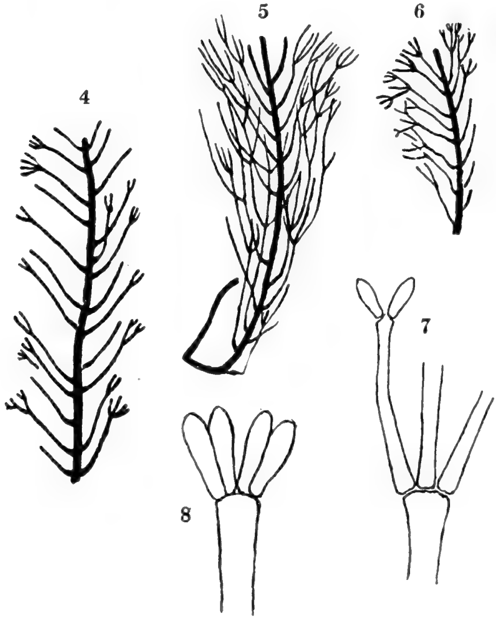
Callithamnopsis Whitfield

Professor Whitfield has proposed this new genus of fossil algae for a form before described by Professor Hall as Oldhamia fruticosa from the Trenton limestone of Platteville, Wis. We have before us a new species from the Trenton of New York referable to this genus and will for this reason enter a little more fully on the discussion of the structure of the better preserved genotype, C. fruticosa. We insert here copies of some of the original figures [text fig. 4–7] illustrating this type and also a camera drawing [pl. 1, fig. 3] of ours of one of the types to show more clearly some of the important features of the form.

The concise original diagnosis of the genus is: "Frond articulate, branched, branches opposite in pairs, in whorls near the upper end of the joints, and composed of single joints between bifurcations."

The camera drawing of the type specimen here reproduced shows the following characters: A distinctly monopodial growth of the thallus with a thick branch of uniform thickness. This retains in some parts a thick carbonaceous test. Where the latter is broken out, a distinct sharp median longitudinal line is seen on the impression dividing the latter into two convex halves, the whole giving the impression of being produced by the crushing of a hollow stem. The apex of the branch is seen to be rounded and sharply defined. In several parts of the main branch distinct

transverse lines are visible which suggest a segmentation of the same corresponding to that of the branchlets. The branchlets of



Callithamnopsis fruticosa Whitfield
FIG. 4–6 Type specimens, x 3.
FIG. 7 Articulation of branchlets, further enlarged
FIG. 8 Terminal branchlets. (Copies from Whitfield)

the first order are always arranged in pairs. Their base is somewhat swollen and also articulates with the main branch. The branchlets of the first order are long and slender. They bear a whorl of four or more shorter branchlets of the second order and each of these again four (or more) short bulbous terminal branchlets in the specimen figured. In others these are again seen to grow out to branchlets of the length of those of the preceding order. No traces of fructification could be found.

The habit of C. fruticosa is clearly algal and there are a number of recent genera, especially among the Florideae, with which it could be readily compared in this respect. Its branching is verticillate in the distal parts and therefore invites comparison rather with forms other than Callithamnion which is typically represented by bifurcating forms. The mode of branching and general structure is so much like that of the preceding genus, Primicorallina, that Callithamnopsis could be considered as a closely related form lacking the incrustation of carbonate of lime.

Professor Hall referred originally to his Oldhamia fruticosa intertwining slender branches which have been separated by Professor Whitfield and described as Chaetomorpha ? prima [*see* text fig. 9, 10]. A specimen on the same slab with some of the types of Callithamnopsis fruticosa reproduced in plate 1, figure 4, leaves, however, no doubt that these stems twisted together are but branches of the latter species which in drifting have become stripped of the branchlets of the higher orders and at the same time through their flaccidity became twisted around each other.

The specimen here figured demonstrates at the same time that the main branch of C. fruticosa bifurcated once or twice, the resulting branches bearing pairs of branchlets.

Chaetomorpha ? prima Whitfield
FIG. 9, 10 Type specimens. (Copies from Whitfield)

Callithamnopsis delicatula sp. nov.

Plate 1, figure 5; plate 2, figures 1, 2

Description. Thallus consisting of segmented monopodial or bifurcating main branch bearing whorls of branchlets which in their turn divide repeatedly in whorls of branchlets of higher order. The main branch is apparently bifurcated. At least such a division is indicated by the specimen plate 2, figure 1, and it would agree with the bifurcation of the main branch in the genotype. It is segmented, for transverse lines that alternate with the whorls are seen in at least one of the specimens [pl. 1, fig. 5]. The branchlets of the next order are somewhat bulbous at their bases and produce an annulation of the main branch. To some extent the latter is also seen to contract between the whorls [*see* pl. 1, fig. 5]. The branchlets are extremely slender and flaccid and therefore much subjected to current dragging [*see* pl. 2, fig. 2]. The whorls of the branchlets of higher orders are far apart and consist only of three or four branchlets. On account of their length the

branchlets are liable to form so dense a mass that they completely envelop the main branch. No fructification has been observed.

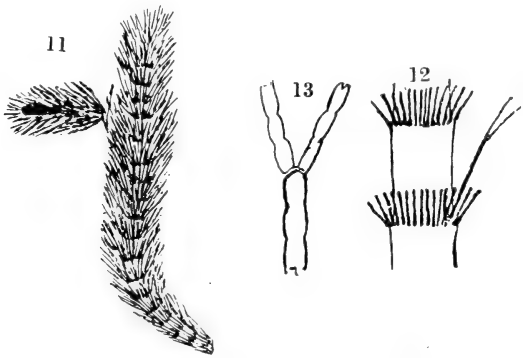
This alga probably possessed a very delicate and minute thallus, the largest fragments not attaining 20 mm in length. The carbonaceous test of the branches is much thinner than in the genotype and also than that of the associated algae in the Trenton limestone at Glens Falls and only visible with good light.

From the genotype it is distinguished by the generally greater tenderness of the whole thallus, that finds its expression in the thinner main branch and thinner and more flaccid branchlets and also in the closer arrangement of the whorls on the main stipe. The contraction of the latter between the annuli produced by the bases of the whorled branchlets constitutes another difference.

Horizon and locality. In the Trenton limestone at Glens Falls, N. Y.

Chaetocladus Whitfield

For a new species of supposed algae from Platteville, Wis., Professor Whitfield has proposed the genus Chaetocladus, characterizing the same as consisting of "Marine plants with jointed cylindrical stems giving off whorls of hairlike filaments at given distances."



Chaetocladus plumula Whitfield

FIG. 11 Type specimen, x 3
FIG. 12, 13 Further enlargements. (Copies from Whitfield)

We insert the original drawings [*see* text fig. 11–13] of this peculiar form for comparison with the form here referred to that genus. It will be seen from the second figure that the branchlets may bifurcate again.

Chaetocladus sardesoni sp. nov.

Plate 2, figures 3–11

Professor Sardeson sent me some years ago a piece of magnesian limestone from the Bellerophon bed (Trenton-Galena bed 2 of his

system) at Minneapolis that contains numerous fragments of the thallus of an exceedingly delicate alga easily mistaken for a graptolite on account of the regularity of its structural features.

The specimens are very slender and preserved only as a brown, mostly thin film, which, however, shows very plainly under water or glycerine. Occasionally also thicker carbonaceous portions are observable. They consist essentially of a uniformly thick or very gradually tapering main axis and regularly arranged whorls of very thin, filamentous branches which from their position in all specimens observed, would seem to have sharply bent upward outside of this thickened base and grown subparallel to the main axis. There were six or more in one whorl. No conclusive traces have been seen in the main axis of either transverse walls, indicating a segmentation or articulation, or of longitudinal walls suggesting a composition of thecal tubes of graptolitic character.[1] The absence of the latter partitions is also suggested by the smooth outside of the main branch.

On account of the arrangement of the branchlets in close whorls on the main branch and the absence of a further division of the branchlets, either by bifurcation or formation of whorls, this species is best brought under Chaetocladus, although it will be noticed that it represents a transitional form between the extremely densely whorled Chaetocladus plumula Whitfield that possesses hardly any further division and Callithamnopsis delicatula that possesses like whorls on the main branch but also a further subdivision of the branchlets that gives it the habitus of a Callithamnopsis.

The most interesting feature of Chaetocladus sardesoni consists in the bulbous swellings of the bases of the branchlets forming the annuli around the main branch. These bulbs are seen in several specimens to have been hollow and to be formed by thicker tissue [*see* pl. 2, fig. 9]. They may therefore possibly have contained sexual or nonsexual propagative organs and correspond to conceptacles observed in some Florideae in a similar position.

Corematocladus gen. nov.

Ety. *Κόρημα* = a broom, *Κλάδος* = a young branch

Thallus composed of thick subcylindric stem that is surrounded by a dense mass of filamentous, frequently subdividing branches. Genotype, Corematocladus densa sp. nov.

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[1] In regard to this observation we have to rely mainly on the natural sections produced by the splitting of the stem through the middle since thin sections failed on account of the flattening of the stem to reveal distinct structures.

Corematocladus densa sp. nov.

Plate 3, figures 1–5

The thallus is small, about 28 mm in diameter and 30+ mm long. It consists of a thick central stem or stipe which most probably was a cylindric branch, but possibly may also have been platelike and attached to other bodies, thus representing only the attachment plate. Its surface is corticated, being covered with a pavement of plates, some of which are distinctly ringlike [*see* pl. 3, fig. 4, 5]. These rings seem to have been the bases of the filamentous branchlets which from their distinct preservation may also have been strongly corticated. The latter bifurcate frequently, the bifurcations apparently following each other more rapidly in the distal portions and in some places they appear to be whorled, dividing into three or probably four branchlets. There are six or more bifurcations in each branchlet from the base to the extremity. The branchlets diverge at small angles and become subparallel. They appear rather rigid and become thinner with each bifurcation, the basal portion reaching about .3 mm in width, the distal portion but .1 mm and less. They are seen to be furnished with transverse walls that in the proximal portion are about twice as far apart from each other as the branchlet is wide and that divide the latter into squarish segments in the distal portion. Directly below the bifurcations the continuity of the branchlet is frequently seen to be interrupted and the segments are slightly inflated on both sides of the line of interruption giving the impression of an articulation.

The systematic position of this small but striking form is at present still very doubtful. The habitus is decidedly more that of an alga than of either a graptolite or of a colonial stock of sertularian or anthozoan affinities, although the strong and glossy carbonaceous test seems highly suggestive of the graptolite nature of the fossil. The absence, however, of cell apertures on the multitude of branchlets[1] and the distinctness of the transverse walls where the test is broken through the middle (they do not show on the smooth outside) are characters favoring a reference to the vegetable kingdom. It must not be forgotten on the other hand that the main axis or stipe might be the theciferous part, the ringlike bases of the branches, the apertures of thecae, while the branchlets themselves were but filamentous processes of the thecae, the form being a Den-

[1] There were seen a few subcircular scars or openings on the test which however are in the place of bifurcations and apparently are produced by the breaking off of one of the branches at the articulation.

droid graptolite and representing a genus near Thamnograptus or Inocaulis. With that supposition, however, the transverse walls and bifurcations of the branchlets would be difficult of explanation.

We do not know of either an alga or an animal form of the Coelenterata with which Corematocladus densa could be directly compared by its habitus. While there are many species forming caespitose tufts among the Florideae, which order on account of the frequent development of strong cortical cells and the transverse septation of the filaments would principally suggest itself for reference, none possess a structure the direct counterpart of that of our species. There are, however, various forms in other orders of marine algae which by their composition of a thick main axis that bears a dense mass of bifurcating filamentous branchlets invite comparison. As such a genus Penicillus among the Codiaceae might be cited, in which an incrusted stipe bears a dense terminal mass of frequently bifurcating filaments.

Munier Chalmas had thought to have discovered this latter form in thin ovoid or fusiform calcareous shells of the Tertiary described as Ovulites which possess on their surface pores surrounded by fine lines inclosing polygonal spaces, the whole forming a structure suggesting somewhat of the main stipe of Corematocladus densa; but as Solms-Laubach has pointed out, no such reticulated design is seen on the surface of the calcified membrane of Penicillus, although he recognizes Ovulites as a calcareous alga. Our form may have been similar in the structure of the main stipe to Ovulites although possessing instead of the calcification a thick noncalcareous cortex.

Horizon and locality. In the lower third of the Trenton limestone at Glens Falls, N. Y.

Mastigograptus ? flaccidus sp. nov.

Plate 3, figure 6

Associated with the described supposed marine algae in the shaly intercalation of the Trenton at Glens Falls and by their flaccid character and carbonaceous film, quite apparently belonging to the same class with them, occur slender wormlike irregularly bent carbonaceous bodies that are distinctly but the macerated fragments of larger organisms. In one case the proximal extremity was observed which is well fitted to throw light on the true nature of this form [*see* pl. 3, fig. 6]. This shows a small attachment plate from which a slender main stipe arises that monopodially gives off equally flaccid and slender branches. Both the stipe and the branches exhibit at regular intervals circular to

transversely elliptic slightly projecting apertures surrounded by a thickened rim and appear to alternate on opposite sides of the stem and branches.

There are no traces of internal walls observable in the badly flattened specimens.

While it is perfectly conceivable that all the apparent apertures could be but the former places of attachment of lost branches, it is also quite as sure that this form, found in another association, would be unhesitatingly referred to the graptolites and brought into the neighborhood of Mastigograptus where it closely resembles in general habit and structure the Utica form, M. arundinaceus (Hall).

As in the case of Corematocladus densa the carbonaceous test is so thick and so glossy that it is more suggestive of the chitinous periderm of a graptolite than of the cortex of an alga and it would require unmistakable algal characters in the composition of the branches and the propagative organs to warrant a reference to the vegetable kingdom.

Horizon and locality. In the shaly intercalation of the lowest limestone beds overlying the "Black marble" at Glens Falls, N. Y.

Concluding Remarks

There are in this paper more fully noted three species of fossils from the Trenton rocks of New York whose position among the marine algae seems fairly well established. These are:

Primicorallina trentonensis *Whitfield* Callithamnopsis delicatula *sp. nov.*
Corematocladus densa *sp. nov.*

The first named is a calcareous alga, which before was placed among the Coralline algae, but is believed by the writer to be a verticillate Siphonea. The other two forms possess only carbonaceous tests and are characterized by the great mass of thin branchlets borne on the axial stem. In Callithamnopsis delicatula these branchlets are arranged in whorls, in the other form they are irregularly distributed on the thick axial stem and frequently bifurcate. The aspect of these forms is that of Florideae and their habitus, which alone is now available, permits of comparison with several families of that class.

It is probable that calcareous algae have played an important rôle in the formation of the limestones of the Trenton formation. This is not only suggested by the frequency of the small joints of Primicorallina in the rock which contains the types, but also by the fact that there occur peculiarly granular and oolitic lime-

stones in the Mohawkian stages (not only in the Trenton and Black River limestone, but also in the Lowville limestone) which may be strongly suspected to be of vegetable origin. In Europe similar rocks of the Lower Siluric have been recognized by Stolley to owe their origin to verticillate Siphoneae. There is neither any doubt that forms corresponding to the important rock-forming nullipores of later eras have been very active then and productive of much of our Lower Siluric limestones, at least in Chazy to Trenton times. This is 1) indicated by the common occurrence in some of our Mohawkian rocks of Solenopora compacta, a form that is placed among the calcareous algae by Rothpletz and considered as either an ancestor of the Coralline algae or as representing an earlier development of a corresponding or parallel branch of the algae, and 2) it is demonstrated by the composition of whole beds of all three divisions of our Chazy by the small nodular bodies described by Seely[1] as a new type of sponge under the name of Strephochetus with a small number of species. Professor Seely's careful figures of microscopic sections, especially of his S. ocellatus, leave, however, no doubt that Strephochetus is identical with Girvanella N. & E. The latter had already been suspected by Nicholson and Etheridge, and later has been proved by Rothpletz to be a calcareous alga, that invites comparison with the Siphonean family Codiaceae. If Girvanella is an alga, much of our Chazy limestone is of vegetable origin.

Also our Beekmantown beds contain strata filled with similar small flat pebbles that are highly suggestive of the water biscuits of our lakes.[2] For these, occurring frequently in upper D. in the so called "Wing conglomerate of Vermont," Seeley has erected the genus Wingia,[3] considering them again as sponges. It is an inviting task to investigate these and other forms of pebbles of the Beekmantown and late Paleozoic stages as to their possible vegetable origin.

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[1] Seely, H. M. Some Sponges of the Chazy Formation. Vt. State Geol. Rep't 1902. p. 151.

[2] Calcareous water biscuit have been described from Canandaigua lake where they largely contribute to the composition of the beach, by Clarke [N. Y. State Mus. Bul. 39. 1900. p. 195]. They are glomerated masses of algae such as are known from many European lakes ("algoid lake balls") that by their own metabolic processes have caused a deposition of carbonate of lime on them. The similarity of the structure of these water balls to that of Girvanella has induced Seward [Fossil Plants, 1895. 1: 125] to place the latter genus among the Schizophyate, a view opposed by Rothpletz [*loc. cit.* p. 5].

[3] Seely, H. M. Contribution to the Geology and Paleontology of Vermont. Vt. State Geol. 5th Rep't 1906. p. 25.

Finally, there is also evidence that already the early Cambric rocks of this State may carry remains of algae. The Lower Cambric shales contain in a number of localities in the slate belt of eastern New York east of Albany, numerous specimens of a stately form [*see* text fig. 14] that was first discovered by T. N. Dale and has been described by Walcott[1] as Oldhamia (Murchisonites) occidens.

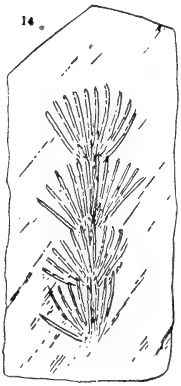

FIG. 14 Oldhamia (Murchisonites occidens. Walcott Original figure. (Copy from Walcott)

The original Oldhamia is now currently considered as of purely mechanical origin [*see* Solms-Laubach, p. 50 and H. Potonié, Lehrbuch der Pflanzenpalaeontologie, 1899. p. 32]. O. occidens, which is by Walcott provisionally referred to the calcareous algae and by Dale to the nullipores, is only found as casts on the surface of a smooth silicious slate and therefore, notwithstanding its highly suggestive form, is still a very doubtful vegetable fossil. The habitus of the form as figured by Walcott is not that of a nullipore, but rather that of one of the many Florideae with whorls of branchlets.

The inference from the before stated facts is that the earlier Paleozoic rocks of New York contain, or are indeed partly composed of, masses of calcareous algae, and that possibly these are even traceable back into early Cambric time. All of these forms require, however, microscopic study of their structure by a competent phytopaleontologist to establish their vegetable origin beyond doubt, and to determine their taxonomic relations by the discovery of the propagative organs.

No calcareous algae have as yet been made known from our Devonic rocks, although their presence there can not be doubted. The Devonic of this State has thus far furnished to us of indubitable algal remains, only the large Thamnocladus clarkei White from the Chemung, that according to its author has the greatest similarity in the external characters with the Fucaceae, and the giant stem of Nematophytum crassum from the Hamilton group of Orange co., N. Y., that is in the New York State Museum and is also referred to the Fucaceae.[2]

[1] Walcott, C. D. Discovery of the Genus Oldhamia in America. U. S. Nat. Mus. Proc. 1894. v. 17, no. 1002, p. 313–15. *See also* Dale, T. N. Geology of the Hudson Valley between the Hoosic and the Kinderhook. U. S. Geol. Sur. Bul. 242. 1904. p. 13.

[2] Penhallow, D. P. U. S. Nat. Mus. Proc. 1893. 16: 117. *See also* Prosser, C. S. Am. Geol. 1902. 29: 372.

EXPLANATIONS OF PLATES

PLATE 1

Primicorallina trentonensis Whitfield

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1 One of the type specimens redrawn, to show the verticillate arrangement of the branchlets of the second order at *a* and those of the third order at *b*

2 Restoration of a thallus

Trenton limestone, Middleville, N. Y.

Callithamnopsis fruticosa (Hall)

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3 One of the type specimens redrawn to show the apex of the main branch and the articulation of the branchlets at the division points and the paired arrangement of those of the first order

4 A specimen on the same slab with the types, exhibiting the twisting of the bifurcating main branches

Trenton limestone, Platteville, Wis.

Callithamnopsis delicatula sp. nov.

See plate 2, figure 1

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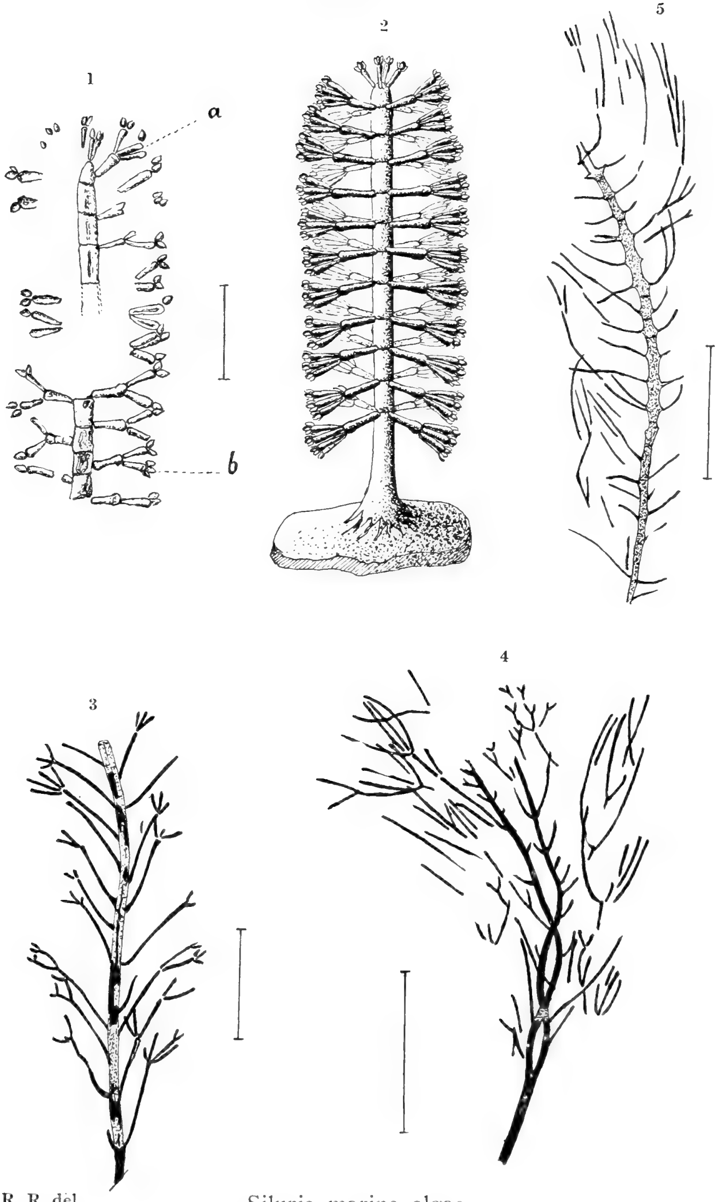
5 Large fragment of thallus showing the segmentation, the alternate contractions and expansions of the branch and the verticillate arrangement of the branchlets

Trenton limestone, Glens Falls, N. Y.

Originals of figures 1, 3, 4 in the American Museum of Natural History, that of figure 5 in the New York State Museum

Plate I



R. R. del.

Siluric marine algae

PLATE 2

Callithamnopsis delicatula sp. nov.

See Plate 1, figure 5

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1 Fragments of two branches in close approximation indicating their production by bifurcation of a single branch

2 A fragment of thallus showing the habitus of the same and the apex. The upper and lower portions lie in different planes of the shale. The specimen shows the effect of current dragging.

Trenton limestone, Glens Falls, N. Y.

Chaetocladus sardesoni sp. nov.

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3, 4, 7 Fragments of the thallus showing, in natural sections, the main branch and the whorls of branchlets

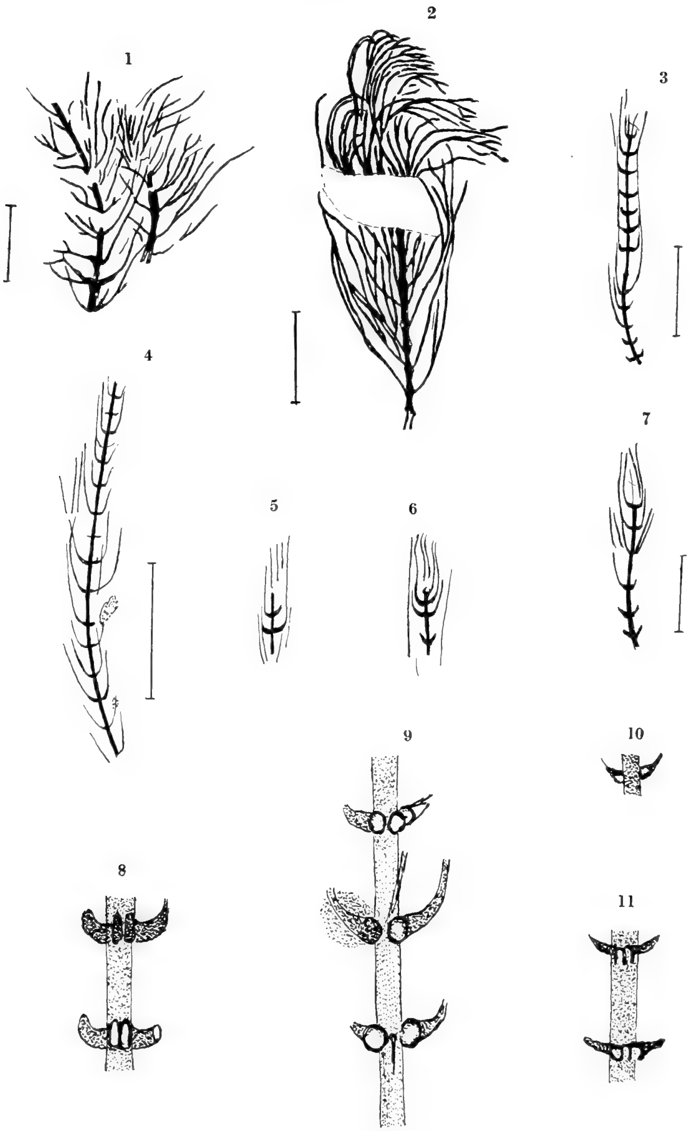
5, 6 The apexes of specimens showing the whorls of branchlets

8–11 Some portions of the thallus more enlarged to show the bulbous bases of the branchlets and their cavities, possibly conceptacles

Trenton-Galena limestone, Minneapolis, Minn.

The originals of all figures are in the New York State Museum.

Plate 2



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Siluric marine algae

PLATE 3

Corematocladus densa sp. nov.

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1 Specimen retaining the thick main branch. Natural size

2 Another specimen (cotype) in which the stipe is either lost or covered by shale, but the corona of small branchlets is shown. Natural size

3 A young thallus with thin stipe, showing well the verticillate arrangement of the branchlets. Natural size

4 Enlargement of a portion of the original of figure 1, to show the surface character of the stipe and the mode of division of the branchlets

5 Enlargement of a small fragment of the thallus showing the bases and the segmentation of the branchlets

Trenton limestone, Glens Falls, N. Y.

Mastigograptus ? flaccidus sp. nov.

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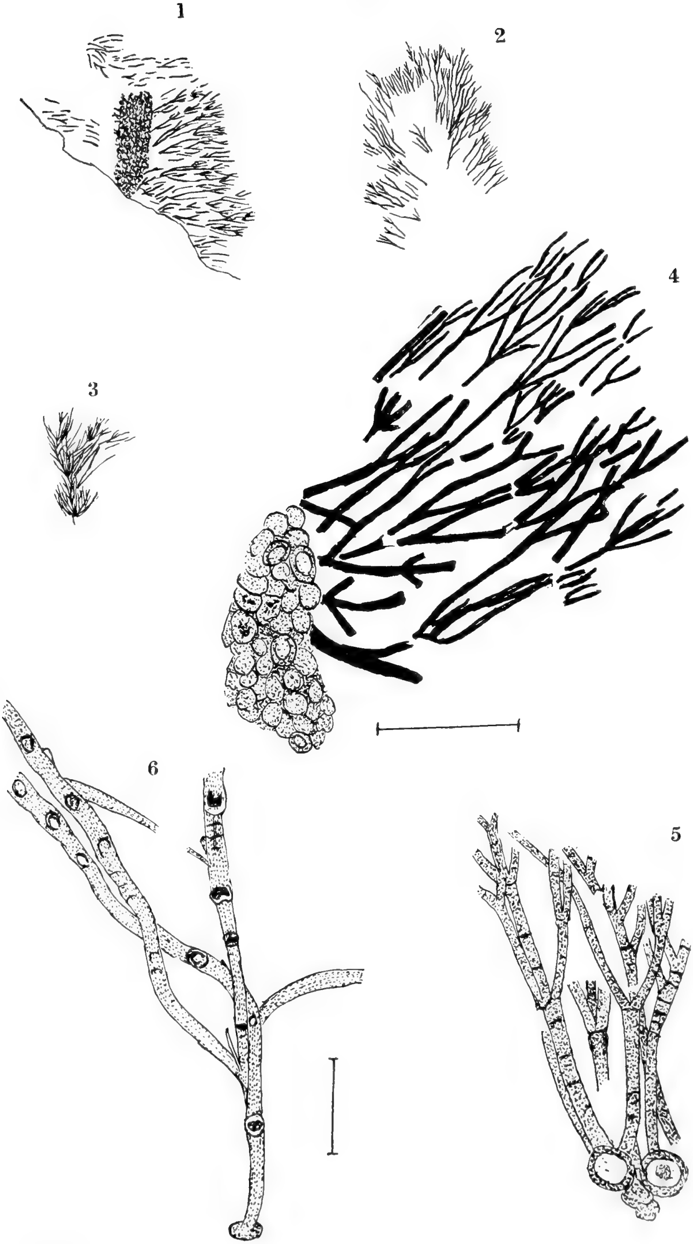
1 Type specimen (holotype). A graptolite that is associated with the algae

Trenton limestone, Glens Falls, N. Y.

All originals are in the New State Museum

Plate 3



R. R. del.

Siluric marine algae

SOME PARALLEL GROUPINGS OF CALCITE CRYSTALS FROM THE NEW JERSEY TRAP REGION

BY H. P. WHITLOCK

1 Calcite from Plainfield, N. J.

The attention of the writer was recently called to some interesting parallel groupings of calcite crystals which were collected in 1903 by Mr Alfred C. Hawkins of Sewaren, N. J., from a locality

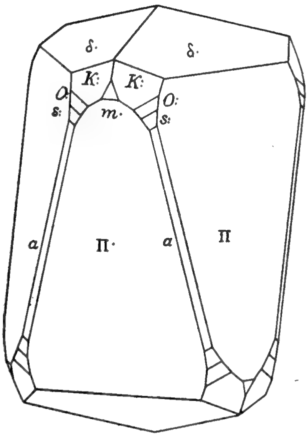


Fig. 1

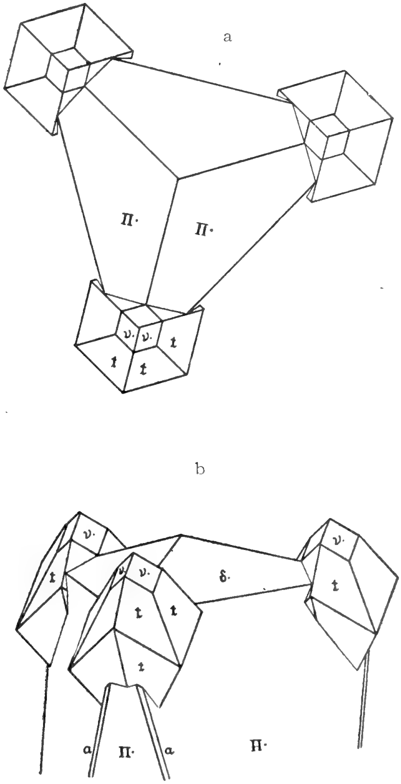


Fig. 2

about 1 mile west of Plainfield, N. J. The writer wishes to express his thanks to Mr Hawkins for the loan of the three specimens which form the basis of this note and for his description of the locality.

The calcite crystals were collected from a road material quarry situated in the first ridge of the Watchung mountains. They occur in vertical veins in Watchung basalt associated with zeolites.

Many of the specimens formerly obtained showed large and beautiful calcite combinations. Those which through Mr Hawkins's kindness are available consist of built-up individuals formed of two superposed types in parallel position and evidently representing two generations of calcite deposition. The compound individuals average 30 millimeters in vertical length. The crystal elements of these compound groupings which represent the earlier generation are rhombohedral in habit. In some instances this habit occurred sufficiently free from the superimposing secondary habit to admit of the determination of the modifying forms. The simple individual of this generation is shown in figure 1 and consists of the negative rhombohedrons δ. $(01\bar{1}2)$ and *II*. $(0\bar{8}81)$ modified by the forms a $(11\bar{2}0)$, m.$(40\bar{4}1)$, K:$(21\bar{3}1)$, O:$(8.5.\overline{13}.3)$ and s:$(17.13.\overline{30}.4)$, the latter of which is new to the species. The crystals of this generation which are slightly more purplish in color and more transparent than those of the superposed second generation in several instances appear as phantoms within the latter. The superposed crystals of the second generation, which are transparent to translucent and slightly yellowish in color, are scalenohedral in habit. They are superimposed in parallel position upon the lateral solid angles of the rhombohedral habit of the s:(17.13.30.4), the latter of which is new to the species. The first generation in the manner shown in figures 2a and b. The dominant form is a new negative scalenohedron $-\frac{5}{4}R\frac{8}{5} =$ $(3.13.\overline{16}.8)$) to which the letter t has been assigned. The scalenohedral habit is terminated by the negative rhombohedron ν. $(05\bar{5}4)$ $= -\frac{5}{4}R$ the two forms lying in the zone $[05\bar{5}4.11\bar{2}0]$. In addition to the foregoing the new scalenohedron lies in zone with the planes $1\bar{1}02 = \delta$. and $0\bar{8}81 = II$. both of which are present in considerable development on the rhombohedral crystals of the first generation. In general habit the superimposed crystals conform closely to that shown in figure 552B of Dana's *System of Mineralogy*, fifth edition, from Bergen Hill. The calculated angles for the negative scalenohedron $-\frac{7}{5}R\frac{3}{2} = (7.35.\overline{42}.20)$ assigned to this combination are X = 87° 14′, Y = 15° 52′ and Z = 68° 14′. The measured values of the angles Y and Z for the negative scalenohedron $t = -\frac{5}{4}R\frac{8}{5} = (3.13.\overline{16}.8)$ are:

Y = 17° 46′; 17° 18′; 17° 48′ and 17° 11′.
Z = 69° 11′; 69° 20′; 68° 51′ and 69° 3′.

The following measurements served to identify the occurring forms:

LETTER	ANGLE	NUMBER OF READINGS	MEASURED		CALCULATED	
			°	′	°	′
$\delta.:\ \delta.''$	$01\bar{1}2 : 1\bar{1}02$	3	45	12	45	3
$p''' .:\ \nu.$	$0\bar{1}11 : 05\bar{5}4$	5	95	22	95	34
$\delta.:\ \mathit{ll}.$	$01\bar{1}2 : 08\bar{8}1$	4	56	14	56	32
$\mathit{ll}.:\ a$	$08\bar{8}1 : 11\bar{2}0$	4	30	50	30	47
$p.:\ m.$	$10\bar{1}1 : 40\bar{4}1$	1	31	14	31	$10\frac{1}{2}$
$p.:\ K:$	$10\bar{1}1 : 21\bar{3}1$	4	29	4	29	2
$K::\ K:''$	$21\bar{3}1 : 3\bar{1}\bar{2}1$	1	35	33	35	36
$p.:\ o:$	$10\bar{1}1 : 8.5.\overline{13}.3$	5	35	57	35	47
$o::\ o:''$	$8.5.\overline{13}.3 : 13.\bar{5}.\bar{8}.3$	1	43	22	43	13
$p.:\ s:$	$10\bar{1}1 : 17.13.\overline{30}\ 4$	5	42	$43\frac{1}{2}$	42	40
$s::\ s:''$	$17.13.\overline{30}.4 : 30.\overline{13}.\overline{17}.4$	1	50	27	50	33
$t:\ t'$	$3.13.\overline{16}.8 : \bar{3}.16.\overline{13}.8$	4	17	31	17	47
$t:\ t''$	$3.13.\overline{16}.8 : 13.3.\overline{16}.8$	4	69	6	69	$1\frac{1}{2}$

2 Calcite from Jersey City, N. J.

Among the minerals recently collected from the Erie railroad open cut which is being excavated through the Jura trias diabase at Jersey City are several specimens of calcite which present an interesting instance of parallel grouping somewhat similar to that previously noted from Plainfield. These specimens, which were collected by Mr James G. Manchester, have through the courtesy of Mr Manchester been made available for study. The calcite occurs in veins in the diabase associated with datolite, apophyllite, natrolite and stilbite all beautifully crystallized. The compound crystals, like those from Plainfield consist of two superposed habits corresponding to two generations of calcite deposition. The earlier generation is represented by crystals of a simple rhombohedral habit consisting of the negative rhombohedron $\pi.$ $(07\bar{7}5)$. In a number of instances these rhombohedral elements occur uncom-

bined with the combination of the later generation and attain a size of 5 centimeters on edge. They have in these instances a markedly cubic aspect. Figure 3 shows the rhombohedron of this phase. The compound crystals which were noted on one specimen of the

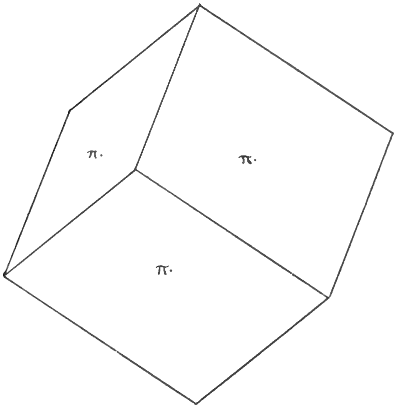


FIG. 3

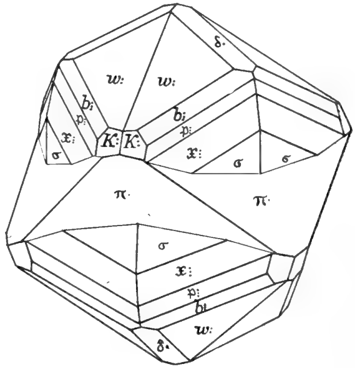


FIG. 4

series available, consist of the rhombohedral element noted above, upon the polar angles of which are superposed in parallel position the scalenohedral combination shown in figure 4. The compound crystals average 10 millimeters in vertical length. On the scalenohedral elements, which represent the later generation of calcite deposition, the following forms were observed: σ $(71\bar{8}0)$, δ. $(01\bar{1}2)$, w: $(3\bar{1}45)$, K: $(21\bar{3}1)$, p: (1341), b: (3584) and X: $(4.16.\overline{20}.3)$. The new dihexagonal prism $= \infty R \frac{4}{3} = (7180)$ is represented by brilliant, well developed planes which gave good reflections of the goniometer signal and lay well in the vertical zone. The following zones were also observed:

$$[1\overline{78}0 : 1\bar{1}02 : 31\bar{4}5 : 35\bar{8}4 : 13\bar{4}1 : 4.16.\overline{20}.3 : 1\overline{78}0]$$
$$[\bar{4}311 : 31\bar{2}1 : 21\bar{3}1 : 13\bar{4}1]$$
$$[\overline{77}05 : 41\bar{3}5 : 31\bar{4}5 : 0775]$$
$$[21\bar{3}1 : 35\bar{8}4 : 0\bar{7}75 : \bar{3}211]$$

Calcite crystals of negative scalenohedral habit were noted on one specimen which yielded measurements approximating those for the scalenohedron $-\frac{11}{12} R \frac{7}{3} = (22.55.\overline{77}.36)$ described by vom Rath from Bergen Hill.[1] The measured angles obtained from the

[1] vom Rath, G. Der Kalkspath von Bergen Hill, N. J. Zeit. f. Kryst. 1877. 2:604.

crystals of this form correspond more closely to the form $-\frac{7}{8}R\frac{5}{2} = (21.49.\overline{70}.32)$. These latter indexes are, however, too irrational to warrant the establishment of the form from the material at hand although the angles are given in the accompanying table for the sake of comparison.

LETTER	ANGLE	NUMBER OF READINGS	MEASURED		CALCULATED	
			°	′	°	′
$\sigma : \sigma^{VII}$	$71\bar{8}0 : 81\bar{7}0$	6	13	11½	13	10½
$\pi. : \pi.^{IV}$	$0\bar{7}75 : 70\overline{75}$	6	90	47	90	55
$\omega :: \omega :^{I}$	$31\bar{4}5 : \bar{3}4\bar{1}5$	2	49	27	49	22½
$\omega :: \omega :^{V}$	$31\bar{4}5 : 4\overline{13}5$	2	15	52	16	0½
$K :: K :^{V}$	$21\bar{3}1 : 3\overline{12}1$	3	35	38	35	36
p: :p :^{I}	$13\bar{4}1 : 1\overline{43}1$	5	27	4½	26	44½
p: :p :^{V}	$13\bar{4}1 : 4\overline{31}1$	6	87	7	87	50½
b: :b :^{I}	$35\bar{8}4 : \bar{3}8\bar{5}4$	1	37	27	37	28
b: :b :^{V}	$35\bar{8}4 : 8\overline{53}4$	1	64	56	64	43
x: :x :^{I}	$4.16.\overline{20}.3 : \bar{4}.20.\overline{16}.3$	5	21	30	21	30
x: :x :^{V}	$4.16.\overline{20}.3 : 20.\overline{16}.\bar{4}.3$	5	96	20	96	26½
x: :x :^{VI}	$4.16.\overline{20}.3 : 16.4.\overline{20}.\bar{3}$	1	42	26	42	27
σ^{I} : x:	$17\bar{8}0 : 4.16.\overline{20}.3$	7	10	15	10	21
x: : p:	$4.16.\overline{20}.3 : 13\bar{4}1$	8	7	32½	6	57
x:: ω:	$4.16.\overline{20}.3 : 31\bar{4}5$	4	53	12	53	5
? : ?	$21.49.\overline{70}.32 : \overline{21}.70.\overline{49}.32$	6	74	7	74	25
? : ?	$21.49.\overline{70}.32 : 70.\overline{49}.\overline{21}.32$	7	30	10	30	3
? ; ?	$21.49.\overline{70}.32 : 49.21.\overline{70}.\overline{32}$	7	60	34	60	28

THE LAST OF THE IROQUOIS POTTERS

BY M. R. HARRINGTON

The ceramic art of the New York Iroquois has long been obsolete. Although the knowledge that their ancestors manufactured vessels of clay still persists among them, none of the technical details remains, so far as I have been able to discover, even in tradition. For this reason I have long been interested in the reported survival of the potters' craft among the Eastern Cherokee[1] who are known to be Iroquoian in language and to have resembled in culture, to a certain extent, the Iroquois of the north. Here, thought I, may be an opportunity to throw light on questions which have long puzzled New York archeologists and to put on record a first-hand account of the art in which the Five Nations had developed such proficiency.

My opportunity came in July 1908, when in connection with my anthropological work for Mr George G. Heye of New York I visited the Cherokee settlements in western North Carolina for the purpose of collecting ethnological specimens.

Before starting I received many helpful hints from Mr James Mooney who has made the Eastern Cherokee an object of special study; thus I was enabled to know approximately what to expect before arriving on the ground. After securing an interpreter I began to make inquiries about pottery, and soon discovered that a number of families still kept a few pieces for their own use, or as mementoes of the old days. As a rule I was able to secure these, but in some cases neither money nor persuasion had any effect — the owners remained obdurate. Nevertheless a very fair collection was secured, comprising specimens of various ages, sizes and uses.

Three principal forms may be distinguished in modern Cherokee ware, as represented by the collection secured for Mr Heye: the large jar (ŭ^{n} tī^{n}), the pot (tū stī^{n}) and the bowl (de wa Lī^{n}). The jars are usually 12 to 16 inches high and average about 8 inches in diameter. Generally these are provided with a flat bottom from which the sides bulge slightly, contracting again toward the rim. Such vessels are usually covered with stamped designs applied with a carved paddle, but no free-hand incised decoration was seen. The name ŭ^{n} tī^{n} while specifically applied to these large

[1] Holmes. Aboriginal Pottery of Eastern U. S. p. 52.

jars, is often used as a generic term for any sort of pottery. Soup, cooked hominy and other foods are kept in such vessels. With the exception of the flat bottom which may be a comparatively recent adaptation to facilitate standing on shelves and tables, this form may well be of aboriginal origin, but bears a greater resemblance to what the New York archeologist would call the Algonquin rather than the Iroquoian type.

A distinct resemblance to Iroquois pottery may be observed in the pots, which often show, to a greater or less extent, a rounded bottom, spheroidal body and constricted neck sometimes surmounted by a projecting rim or collar, all of which features are characteristic of Iroquois ware. The rim is sometimes even decorated with notches, dots and simple incised lines, which add to the Iroquois effect as in the jars the body is frequently covered with stamped paddle patterns. Such pots were formerly employed for general cooking purposes but have been recently used more for stewing fruit than anything else. The hight of the modern specimens is generally under 8 inches, but in former times larger ones were made. One small vessel of this type was provided with handles of modern design.

Bowls are variable as to size and various as to use; some are round bottomed, some flat, some stamped, some plain; but the rims of all the bowls collected were invariably more or less flaring, not bent sharply inward as in many Muskhogean and some modern Catawba specimens. Similar flaring bowls are occasionally found on northern Iroquois sites. The only saucerlike form seen was made, the Indians told me, in imitation of white man's ware. When baking a batch of pottery the old Cherokees were accustomed to put in a lot of little toy vessels, dolls and animals modeled in clay, which were greatly appreciated by the children. Crude clay pipes were also made, and these too were reproduced in miniature as toys. Such toy vessels, figurines and pipes are not infrequently unearthed from ancient Iroquois sites in New York.

Mr Mooney had given me the name of one potter, Iwi Katâlsta, and I lost no time in making her acquaintance. Inquiry resulted in the discovery of but one more, an aged woman known as Jennie Arch, whose feeble hands had all but lost their skill. For this reason I confined myself almost entirely to Iwi's methods of pottery making. Fully half the pottery I secured from the Eastern Cherokees is said to be the work of her hand.

Her tools were few, and with one exception simple, consisting of a hammerstone for pounding the clay, a sharpened bit of stick

for making lines and notches, and a fine grained, waterworn pebble for smoothing, showing the polish of long use. The exception is the carved paddle for stamping the pottery — a broad bladed wooden affair about 8 inches long, carefully carved to produce a checkerwork pattern when struck against soft clay. More paddles were later collected bearing different figures, some quite complex. Other accessories were a common axe, a bucket of water, a low sided wooden tray for kneading clay and a flat oval piece of wood used as a stand to build large jars upon and provided with a handle at either end for convenience in turning; some saucers of china or gourd, and some pieces of cotton sheeting.

After Iwi Katâlsta had dug her clay from a bed on Soco creek, the exact location of which she did not seem inclined to reveal, she was accustomed to mold it into a cake some 14 inches long, resembling in form a loaf of bread, in which shape it was dried and laid away for future use. When we visited her home at "Yellow Hill" [pl. 1] and requested her to make us some pottery she broke off the end of this cake and proceeded to pulverize it on her hearthstone, using the back of a common axe as a crushing instrument. In old times, she explained, a "long rock" was used for this purpose.

When sufficiently pulverized the clay was placed in a wooden tray, moistened and again thoroughly pounded [pl. 2]. This time Iwi used a hammerstone which she kept especially to crush hickory nuts, but which she often used in place of the axe in pounding the dampened clay. From time to time the mass was kneaded and a little more water or dry clay added as seemed necessary to obtain the required consistency. Sometimes, I was informed, a fine sand was added at this stage as a tempering material; but in this case it was omitted. Iwi had a vessel of the pot form in mind. Taking a large handful of the clay she patted it into a ball which she took in both hands and pressing her thumbs deeply into one side, began to turn it rapidly [pl. 3]. In a surprisingly short time a small bowl with fairly thin sides was produced to serve as a base for the future vessel. During this process she had taken care to keep her hands wet. Then supporting the inside of the bowl with the fingers of her left hand she struck it sharply on the outside with her carved paddle, slightly turning the embryo vessel before each stroke and moistening the paddle now and then in a vessel of water which stood near. The bowl-shaped base was then carefully laid upon a bit of cotton cloth resting on a common china saucer. When questioned as to what the Indians

used before saucers were available, Iwi replied through the interpreter, that she had heard that for large vessels the base was set in a hole in the sand lined with some sort of cloth, the sand being often inclosed in a basket for convenience. For small vessels, she said, a saucer made of gourd was just as serviceable as one of china, and as I liked the old style, she would take care to use gourd supports hereafter in making pottery for me. It was her custom, she continued, when making the large, flat-bottomed hominy jars to set the base on the oval, flat utensil of wood before mentioned, especially made for the purpose and provided with a handle at either end to facilitate turning.

The bowl-shaped base having been safely ensconced in the saucer she pinched its edges thin with wet fingers; then, rapidly rolling out a lump of clay on a plank into a long thin cylinder [pl. 4] she applied it just inside the rim of the base and projecting above it about half its width, pinching it fast the while until the circuit was completed [pl. 5]. The coil proved a bit too long, so she broke the superfluous piece off and blended the two ends together with care. Then by careful pinching and smoothing with wet fingers and finger nails the coil was blended with the bowl-shaped base and thinned at the top to receive another coil which was also applied inside. The object of applying each coil inside instead of directly on top of the preceding was to produce strength by overlapping. Thus the coiling proceeded until the required form and hight were reached, when the rim coil was applied outside the one beneath. After being blended in the usual way this was pinched into lateral protuberances, and notched, dotted or marked with a sharpened stick to suit the fancy [pl. 8]. After each coil had been applied and blended the vessel was allowed to dry and harden a few minutes before the next one was added; and after the jar had received its shape it was allowed to become quite firm before the final stamping was applied.

It will be remembered that the base of the vessel had already been stamped before being placed in the saucer, so it was now only necessary to strike the body briskly with the wet paddle until the surface was covered with its imprints [pl. 6]. In one jar the stamping was complete before the rim was added. After stamping the vessel was set away to dry.

The fact that Iwi used no tools except the paddle, the marking stick and her fingers seemed remarkable to me, in view of the numerous smoothing tools of gourd, shell and wood employed by

the Catawba.[1] Inquiry revealed the fact that while they had apparently never heard of gourd smoothers, the Cherokee formerly used mussel shells and a marine shell, probably some species of *cardium* for this purpose. Iwi herself sometimes used a chip of wood in making large vessels.

After drying — a process that takes from one to three days, depending on the weather — the vessel was carefully rubbed and polished on the inside, and on the outside whenever necessary [pl. 7] with the smoothing stone kept wet by continual dipping in water.

When a number of vessels had been made and dried the next step was to prop the vessels up on their sides around the fire, mouth toward the blaze, until a faint brown color, beginning near the fire crept over the whole of the vessels — a sign that they were hot enough for firing. Then the potter, with a long stick, rolled them over mouth down upon the embers [pl. 9] and covered them with pieces of dry bark to the depth of 2 or 3 inches. Making sure that the bark had caught fire all around [pl. 10] she left them to their fate. About an hour later the bark had burned away leaving the rounded bottoms of the pots protruding through the ashes. Then, taking her long hooked stick, Iwi rolled the vessels from the fire, tapping them sharply to detect cracks. If a vessel rang clear it was perfect.

"In order to be good for cooking, these pots should be smoked," she said. "If this is not done the water will soak through." So she dropped a handful of bran in each one while they were still almost red-hot, stirred it with her stick, tipped the pots this way and that, and finally, turning out the now blazing bran from each in turn, inverted the vessels upon it. In this way the inside was smoked black and rendered impervious and this without leaving any odor of smoke in the vessels when they became cold. Generally, Iwi told me, corncobs were employed for this purpose, but she always used bran when cobs were not available. This probably explains the black color of the inner surface so often seen in New York aboriginal pottery.

I was told that in later times the firing has been generally done indoors, because an absolutely still day was necessary for a successful burning in the open air, any breeze being liable to crack the vessels. The firing of my pottery was, however, done out of

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[1] Harrington. Catawba Potters and their Work. *Am. Anthropology,* Sept. 1908.

doors, the fire being built on a rude hearth of flat stones sunk level with the ground.

It seems probable from the evidence at my disposal[1] that similar methods were once used by the New York Iroquois in making pottery. As before mentioned the form of many Cherokee vessels is quite like the style we know as Iroquois. Similar rims are found in western and northern New York, as are potsherds showing the overlapped method of coiling, while from the ash pits on the early Mohawk site known as "Garoga" in Fulton county, New York I have unearthed with my own hands pottery bearing the impress of the checkerwork paddle.

But the ancient pottery of the Cherokee embraced forms still more like the Iroquois styles than are those of modern make, if we can judge by the specimens found near the "Town House Mound" at Yellow Hill on the Eastern Cherokee Reservation — a mound which the Cherokee claim was made by their ancestors. The pieces of rim and the single perfect vessel would not be considered intrusive or imported if found on an ancient Onondaga site in Jefferson county, New York. They show not only the spheroidal body, constricted mouth and projecting rim or collar, but also exhibit a well developed neck of true Iroquois style which is not clearly marked in the recent ware of the Cherokee.

The carved paddle for decorating pottery seems to have become obsolete among the Iroquois at an early date, for potsherds showing its use are rarely if ever found on their later sites so far as my knowledge goes. But such potsherds are not seen as a rule on New York sites once occupied by Algonquin tribes, so it is probable that here we have another link connecting the northern Iroquois with the Cherokee. The blowgun, the nearly universal possession of the southeastern tribes, seems also to have been peculiar to the Iroquois in the north. Possibly such apparent trifles may help us to trace the migrations of the Iroquois before they reached the region of Lake Erie and the St Lawrence.

It was perhaps fortunate that I was able to go to North Carolina when I did, for Iwa Katâlsta is old, and her health is failing, while Jennie Arch can no longer make pottery worthy of the name. The younger generation does not care, apparently, for pottery making, and the western Cherokees, from all I can learn, have abandoned the art. Hence it is probable that a few more years will see the last of the Iroquoian potters.

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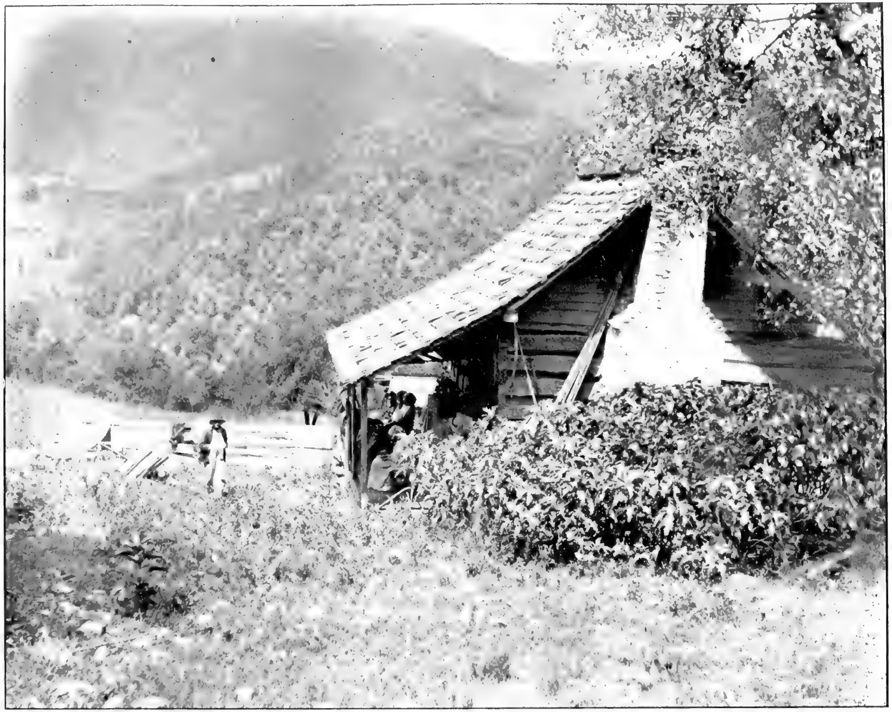
[1] Iroquois Industries.

Plate I



Home of the Cherokee potter

Plate 2

Pounding clay for pottery

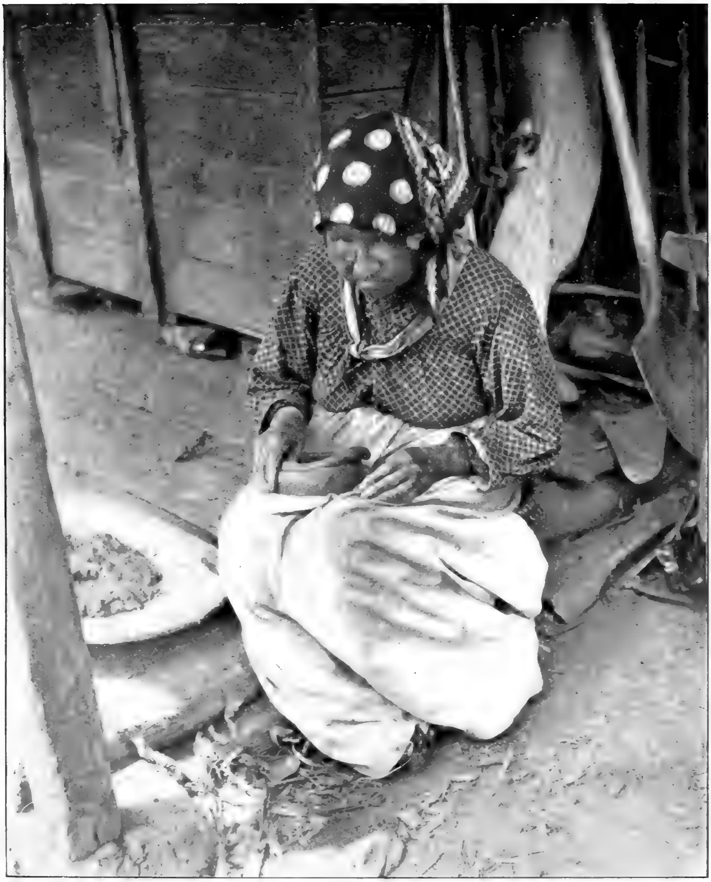
Plate 3

Molding the bottom of a vessel

Plate 4

Rolling the coil of clay preparatory to making a pottery vessel

Plate 5



Applying a coil to the pot base

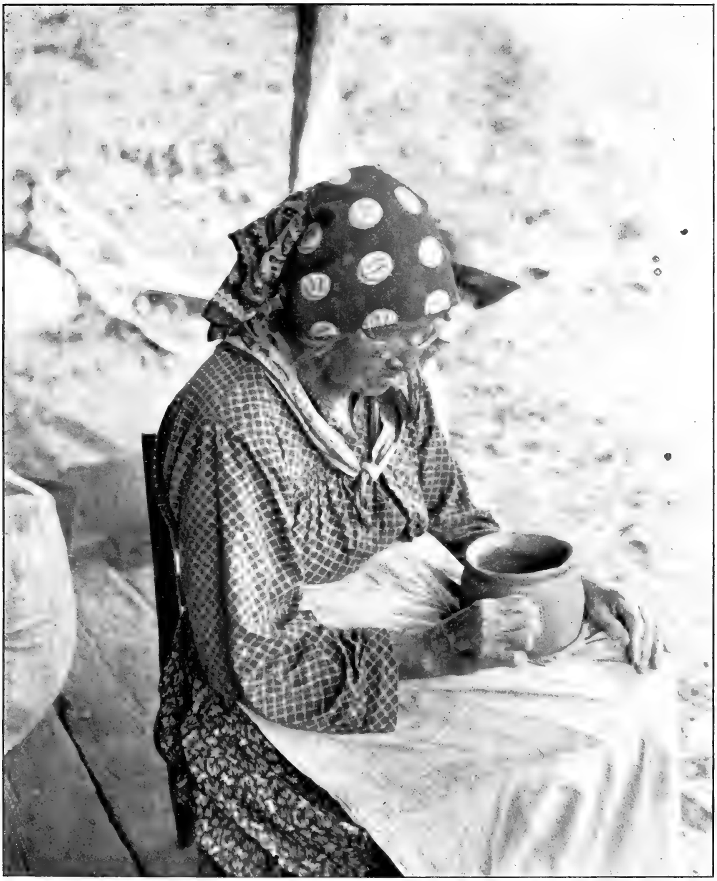
Plate 6

The use of the stamping paddle

Plate 7

The polishing stone in use

Plate 8



Decorating the vessel

Plate 9

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Plate 10

Firing the clay vessels

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Education Department Bulletin

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No. 440 ALBANY, N. Y. February 1, 1909

New York State Museum

John M. Clarke, Director

Museum bulletin 126

GEOLOGY OF THE REMSEN QUADRANGLE

INCLUDING TRENTON FALLS AND VICINITY IN ONEIDA AND HERKIMER COUNTIES

BY

W. J. MILLER

New York State Education Department
Science Division, July 2, 1908

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, a report on the Geology of the Remsen Quadrangle, including the Vicinity of Trenton Falls, N. Y., accompanied by a geologic map of the region. The work has been prepared by Prof. W. J. Miller of the staff of this division.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 3d day of July 1908

A. S. Draper

Commissioner of Education

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GEOLOGY OF THE REMSEN QUADRANGLE

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BY

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INTRODUCTION

The territory described in this report is covered by the Remsen quadrangle of the United States Geological Survey. The map covers $\frac{1}{16}$ square degree and lies between latitude lines 43° 15′ and 43° 30′ north, and between longitude lines 75° and 75° 15′ west. The region, partly in Oneida and partly in Herkimer county, lies along the southwestern border of the Adirondacks. The map represents nearly 216 square miles of territory and includes the type locality of the classic Trenton limestone formation. The gorge at Trenton Falls has long been famous both for its scenic beauty and because of the interesting geological section there shown.

The whole territory was formerly heavily forested, but at the present time the woods are confined almost entirely to the northeastern part and even there much of the timber is of second growth. A number of sawmills are now in operation as at Nichol's Mill,

Forestport, Remsen, Bardwell Mill, one on Little Black creek, Northwood, Grant, and a large pulp mill at Hinckley, within the territory. The southwestern half of the region is devoted primarily to agriculture and dairying.

GENERAL GEOLOGIC FEATURES

Under this heading it is proposed to briefly outline the geologic history of the whole Adirondack region so that the detailed study presented in this report may be made more intelligible to the reader. This outline is largely based on the admirable treatises of Prof. H. P. Cushing.

So far as known the oldest rocks of the Adirondacks are those of Grenville (Precambric) age. They are sedimentary rocks, originally shales, sandstones and limestones, which have been highly metamorphosed into gneisses and crystalline limestone. These rocks are of unknown though great thickness, and are widely scattered throughout the Adirondacks, thus showing that the whole region was under water at the time of their deposition.

After the deposition of the Grenville sediments the region was raised above the ocean level and the rocks began to decompose and suffer erosion. Either just before, during or after the uplift, great masses of igneous rocks were intruded. The Grenville rocks were for the most part engulfed by the intrusion so that only occasional patches of them were left intact.

After the igneous activity the rocks became thoroughly metamorphosed by being squeezed, highly folded and converted into gneisses. Such changes can take place only at great depths (several thousand feet) and hence we are led to the belief that a vast erosion of the original land masses must have taken place. This in turn signifies that the land masses must have remained above sea level for an immense length of time.

At or toward the close of this long period of erosion, igneous activity of a minor character took place. The basic igneous rocks erupted at this time are especially well shown in the northeastern Adirondacks where they were squeezed up between joint planes in the older rocks. That these rocks are much younger than the igneous rocks first mentioned is clearly shown by their mode of occurrence and their general lack of metamorphism.

At the conclusion of the erosion period the region of the Adirondacks was nearer the sea level and of slighter relief than at present. Then the whole region began to sink slowly, allowing the sea to encroach upon the land until only an island was left or probably

even until the whole region was under water. During the subsidence, deposition of Paleozoic sediments went on, one layer above another, the younger deposits overlapping each other and encroaching upon the sinking land surface. Since the subsidence was not entirely uniform on all sides certain local variations in deposition occurred.

The first of the deposits to form upon the sinking floor was the Potsdam (Cambric) sandstone now found exposed nearly everywhere except along the southwest border. After this the sediments changed in character and the limestones of the Beekmantown (Lower Siluric) were laid down. Then followed the deposition of the highly fossiliferous Trenton (Lower Siluric) limestones, including the Lowville and the Black River limestones. The fairly clear waters full of animal life then gave way to the muddy waters of the Utica, when the Utica shales (Lower Siluric) were deposited. At this time the Adirondack region was probably all under water. Next came an uplift on the east and northeast where deposition ceased. On the south and southwest, however, deposition continued and the successive formations of the Siluric and Devonic above the Utica shale were laid down. These Paleozoic formations may now be seen as one passes from the Adirondacks southward to the southern border of the State.

The last period of igneous activity in the Adirondacks occurred some time after the close of the Lower Siluric. This activity was of minor extent and showed itself in the form of dikes.

At some time after the deposition of the Utica shale the rocks, especially along the southern border, were deformed chiefly by faulting. A series of these faults extends across the Mohawk valley, a small one being present within the limits of the Remsen quadrangle. The southern Adirondacks, including the Trenton Falls district, have been subjected to erosion for a vast length of time, certainly since the close of the Paleozoic and more than likely since the Devonic. During this great lapse of time a large amount of material has been removed. Doubtless the whole Remsen quadrangle was at one time covered by the Utica shales, which have all been removed except along the western side.

The superficial deposits, such as sands, gravels and clays, which are so common over the Trenton Falls district were deposited either directly or indirectly by the great ice sheet of the Glacial age. From the geological standpoint this ice sheet was present only quite recently and covered most of New York State.

TOPOGRAPHY AND DRAINAGE

The region of the Remsen quadrangle presents a very ancient topography since it has been above water and subjected to erosion at least since the close of the Paleozoic era. The major topographic features are the result of this long continued wear, but the whole region has been thoroughly glaciated, and the detailed surface configuration has often been quite appreciably affected by the accumulation of glacial drift.

The region is a characteristically hilly one, with the greatest difference in altitude above sea level being from a little over 700 feet, where West Canada creek leaves the map, to nearly 1900 feet in the extreme northeastern portion, where several points reach to and above the 1800 foot level.

Extending northeastward from a line passing through Forestport and Grant, to the highlands just mentioned, there is a gradual upward slope which continues into the Adirondacks. In fact these highlands may be looked upon as foothills of the Adirondacks. Minor highlands occur in the west-central part of the district where the culminating point is Starr hill over 1780 feet above sea level. From Starr hill southward the general slope is towards the Mohawk river. As Professor Brigham has said, the magnificient view from the top of this hill strongly impresses one with the greatness of the Mohawk valley as a topographic feature.

The country lying between the two highland areas is mostly drift covered and shows usual elevations of from 1100 to 1400 feet. The central and southeastern parts of the quadrangle are deeply drift covered, the drift ranging from 100 to 300 or 400 feet deep and the hill tops ranging from 1300 to 1500 feet above the sea level.

The principal streams are Black river and West Canada creek, the latter stream being the chief tributary of the upper Mohawk river. These two streams present some of the most interesting drainage features of the southwestern Adirondacks. They have their sources close together in the Adirondacks and they flow southwestward approximately parallel for 30 or 40 miles to within the map limits where a striking divergence occurs. Black river turns northwestward or at right angles to its upper course, while West Canada creek turns southeastward and also at right angles to its upper course. At one point within the map limits the two streams are but little more than 4 miles apart. Black river continues northwestward to Carthage and thence westward into Lake Ontario; while West Canada creek continues southeastward and southward

to empty into the Mohawk river at Herkimer. Thus Black river forms a part of the St Lawrence drainage system while West Canada creek forms a part of the Mohawk-Hudson system.

Another striking but well known feature of Black river is the fact that it follows close to the Paleozoic-Precambric contact for many miles. Doubtless the character of the Paleozoic rocks (mostly limestones) has had much to do with the determination of its course along this line.

The main tributaries of Black river within the map limits are Big and Little Woodhull creeks on the north and Little Black creek on the south. The main branch of West Canada creek on the north is Town Line (Cincinnati) creek and on the south Black creek.

Certain other topographic and drainage features are discussed in the following pages.

ROCKS OF THE REGION

The rocks of the region include Precambric crystallines and Paleozoic sedimentaries. Each of these rock classes occupies approximately one half the area and they are separated on the geologic map by a line running southeast and northwest. The Precambric rocks represent a portion of the great Adirondack crystalline mass along its southwestern border. The Paleozoic rocks are of Lower Siluric age and overlap on the crystallines.

Precambric rocks

Grenville gneiss. Rocks of Grenville age comprise a series of highly metamorphosed sediments and they occur in but one well defined area within the map limits. This area, nearly triangular in shape, covers several square miles and extends from Enos south and southwestward. The best exposures are in the vicinity of Enos where for about a mile downstream Black river has cut a gorge through the Grenville rocks which are finely exposed. Another large outcrop may be seen where a road crosses Little Black creek about a mile and a half from its mouth. Grenville rocks have been found in many other parts of the region but they are so thoroughly involved with syenitic masses that they can not be separately shown on the geologic map.

Where the Grenville rocks are found in considerable areas in the northwestern Adirondacks, crystalline limestones are commonly associated with them, and the limestone proves the original sedimentary character of the formation. These characteristic crystalline limestones have not been found in the region here described.

They have recently been found in the adjoining Little Falls district.[1] Cushing notes the presence of limestone boulders near the northern edge of the Little Falls sheet which makes it probable that the limestone occurs on the Wilmurt sheet which lies east of the Remsen sheet. Another occurrence is at Fourth lake of the Fulton chain.[2] Thus it appears that the Grenville limestones are only poorly developed along the southwestern border of the Adirondacks.

The strongest evidence for the original sedimentary character of the Grenville rocks within the Remsen quadrangle is the fact that layers of very different composition and color are in sharp contact and often show rapid alternations. Such phenomena are well exhibited in the Black river gorge at Enos, where the rock layers stand in almost vertical position and strike n. 70° e. Near the old mill there are many layers of very light color made up almost entirely of feldspar and quartz. These rocks must originally have been beds of feldspathic sandstone and it appears probable that the present banding corresponds closely to the former stratification of the sandstone. These light colored layers are clearly interbedded with dark gray and almost black feldspathic and hornblendic or biotitic rocks. Although some of these darker rocks appear to be of igneous origin and closely associated with the Grenville, nevertheless many of them are more than likely of sedimentary origin and were probably originally shales.

Another strong evidence for the sedimentary origin of the Grenville rocks is the presence of graphite in them. Graphite flakes often a millimeter or more across and exhibiting a shiny metallic luster are very common in certain of the lighter gray layers near the mill at Enos. More rarely the graphite occurs in the darker layers. It is difficult to account for the graphite except on the basis of organic origin. Thus we may argue that the original sandstones and shales were more or less carbonaceous and during the process of metamorphism the organic matter was changed and crystallized into graphite.

Another mineral suggesting a sedimentary origin which is often found in light red crystals, especially in the darker layers, is garnet. Garnets are rather more frequently present in metamorphic rocks of sedimentary origin and their presence here, often in abundance, seems to suggest such an origin for the Grenville.

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[1] Professor Cushing has called the writer's attention to the discovery of this limestone by D. H. Newland. *See* N. Y. State Mus. Bul. 119. p. 143.

[2] Smyth, C. H. jr. Crystalline Rocks of the Western Adirondacks. N. Y. State Mus. 51st An. Rep't, v. 2. 1897.

The Grenville presents many different facies and below follows a description of the principal types which are represented by different layers. A common type is distinctly marked by alternating light and dark bands, the light bands consisting mostly of plagioclase feldspar and quartz, while the dark bands are chiefly biotite mica and hornblende together with garnet.

Another type is of light gray to greenish gray color and rather fine grained. The principal constituent is augite with a fair amount of anorthoclase and quartz together with several per cent of graphite.

A third type shows a very thin banding, is almost white and is made up chiefly of plagioclase (oligoclase) feldspar with some quartz.

A fourth type is fine to medium, light colored, and is made up of about 75% of anorthoclase, 20% of quartz and 5% of biotite, magnetite and garnet.

A fifth type is dark gray micaceous, consisting of about 60% of oligoclase, 25% of biotite mica, 10% of quartz and a little magnetite and hornblende.

A sixth type, which is rare, consists mostly of enstatite (or bronzite) with some quartz.

A seventh type contains much sillimanite accompanied by anorthoclase, quartz, magnetite and biotite. The sillimanite occurs in long glistening needles visible to the naked eye. This type was observed only near Forestport, where Grenville and syenite rocks are closely associated.

Accompanying the above described Grenville rocks and interbanded with them are certain rock types which are presumably igneous in origin. One of these rock types is gray, medium grained and consists of about 50% of feldspar — anorthoclase and oligoclase — 25 to 30% of quartz, varying amounts of hornblende, hypersthene, biotite mica, magnetite, and a little pyrite, apatite and zircon. Found alone in the field it would be impossible to distinguish this rock from the typical syenite below described.

Another of these rocks thought to be igneous in origin is black, fine grained and highly banded. It consists chiefly of hornblende (50 to 60%) associated with plagioclase feldspar (30 to 40%) which ranges from oligoclase to labradorite and about 5% of magnetite. According to the composition the original rock would have been a gabbro. These apparently igneous rocks can in no case be represented as separate areas upon the map.

Since the rocks of the Grenville series have been so profoundly

changed by metamorphism, it is possible that the rocks above referred to as igneous may not be igneous at all, while others not referred to as igneous may in reality be igneous. Nevertheless most of the rocks of the series appear to be of undoubtable sedimentary origin.

Syenite gneiss. A considerable portion of the region mapped as Precambric is made up of a rock which shows every indication of being truly igneous in origin. Also its areal distribution and relation to the Grenville rocks [*see* below] clearly indicate that it is intrusive in character. Study shows this rock to be a syenite gneiss. It is from fine to medium grained and shows the typical granitoid texture. The weathered surface of all exposures is of a light brown color, while the real color of the fresh rock is greenish gray. Because of the depth of the weathering the fresh rock is usually difficult to obtain. As compared with the other Precambric rocks this syenite presents a remarkably uniform structure and composition throughout. Near the contact with the adjacent syenite-Grenville complex (below described) the rock is usually somewhat finer grained and not so typical in character.

Of the two areas mapped, the larger is very irregular in shape and occupies much of the northeastern portion of the district. This mass is mostly heavily wooded and the exposures are often few in number and unsatisfactory. However, many large exposures have been found, especially in the vicinity of Northwood, North Wilmurt, Reeds Mill and on the Little Black creek near the county line. The smaller area lies in the town of Forestport extending northeastward from Forestport station for several miles and on either side of the railroad. Although much of the area is sand covered, excellent exposures may be seen at Woodhull, Meekerville and in the stream beds southeast, west and southwest of Anos Siding.

The syenite clearly exhibits a gneissic structure although it is not distinctly banded. The concentration of dark colored minerals such as biotite and hornblende along certain lines serves to accentuate the gneissic structure. These lines are wavy and as a rule do not extend far without interruption. All the outcrops show the gneissic structure although it is not always evident in the hand specimen.

Under the microscope the mineralogical composition is shown to be feldspar — including anorthoclase, microperthite, and acid plagioclase — quartz, hornblende, biotite, augite, enstatite (or bronzite), magnetite, apatite, zircon, titanite.

The most abundant constitutent is feldspar, which shows a range of from 65 to 80%, while the average amount present is a little over 70%. Of the feldspars, the anorthoclase and the microperthite are most common, sometimes the one and sometimes the other predominating. The anorthoclase is recognized by the very minute multiple (microcline) twinning bands, often indistinct but presenting a sort of moiré effect. Occasionally the multiple twinning is more distinct and then the feldspar may indeed be microcline. Microperthitic intergrowths especially in the larger feldspars are often beautifully shown. Acid plagioclase is a constant constitutent of the syenite, though always subordinate in amount. It is mostly oligoclase with low extinction angles although at times some of it ranges over to andesine.

The second most abundant mineral is quartz, which makes up from 10 to 25% of the rock or on the average a little over 15%. The quartz grains vary greatly in shape and size and sometimes they are larger than the feldspars. The quartz percentage is often high enough to make the rock a quartz syenite at times approaching granite. The quartz, as well as the feldspar, in nearly all cases appears to have been entirely recrystallized.

Among the dark colored minerals hornblende is a very constant constituent. It appears to be common hornblende with its characteristic cleavage and pleochroism from light to dark green. Often it may be seen partly or completely changed to chlorite. The maximum amount of hornblende present is about 10 or 12%.

Biotite mica is also always present in scattering flakes, never making up more than 5% of the rock.

The pyroxenes — augite and enstatite (or bronzite) are frequently present but always in small quantity.

Magnetite — never above 5% — is a constant constitutent. The development of leucoxene borders around the magnetite may often be seen.

Many very small prismatic crystals of apatite, generally as inclusions in feldspar or quartz, occur scattered through the rock.

Besides the minerals mentioned occasional small crystals of zircon and titanite are present. All of the dark colored constituents may occur in the same specimen but together they never make up more than 20% of the rock.

Syenite-Grenville complex. The rocks here described occupy approximately one half of the Precambric area. Rocks of many different kinds have been included under this head and, both because of the small scale of the map and the scarcity of exposures, it has not been possible to separate these rocks upon the geological map.

The term "Syenite-Grenville complex" is used by the writer because the rocks, for the most part at least, appear to be a rather intricate mixture of the syenitic and Grenville rocks already described. Especially in certain of the large exposures, as in the vicinity of Forestport, Myers hill, north of Enos, near the northern limit of the map along the railroad, etc., rocks which if present alone would undoubtedly be classed with the syenite are closely associated with others which show characteristic features of the Grenville. The two rocks show great variation in amount although the syenites generally predominate. In large exposures in the field the rocks of the complex may be easily distinguished from the typical Grenville because the bands are not so well developed and straight, and also because of the basic inclusions. They differ from the pure syenite because of a better development of the gneissic structure and a decided lack of homogeneity.

There is strong evidence that the Grenville sediments are the older and that the syenite has been intruded into them. One argument in favor of this view is the fact that the two rocks are so thoroughly involved and that neither may be said to rest upon the other. But the strongest argument lies in the fact that portions of the rocks mapped as Grenville may be seen as actual inclusions within the syenite. Among the localities where such inclusions occur are: at the bridge near the mouth of Little Black creek; 2 miles east of Enos on the south side of Ash ridge; near Forestport; where the railroad crosses Big Woodhull creek; and to the south of Myers hill. Thus the syenite appears to be intrusive into and therefore younger than the Grenville. Certain results obtained by C. H. Smyth jr[1] in the western Adirondacks seem to point to the same conclusion.

Because of the great variety of rocks mapped under this heading and the frequent gradations of the different types into each other it is very difficult clearly to describe them. In general it may be said that nearly all of the minerals occurring in either the Grenville or the syenite have been found in this complex and also that the microperthite is lacking while the anorthoclase, plagioclase and quartz as well as the dark colored minerals show all sorts of variations in relative abundance.

The most common type is a rock of syenitic character, which in the hand specimen very closely resembles the homogeneous syenite already described. Although under the microscope the rock shows a general lack of microperthite and a greater richness

[1] N. Y. State Mus. 51st An. Rep't, v. 2. 1899.

in oligoclase and the dark colored minerals, it is nevertheless thought to be a facies of the homogeneous syenite mass. The difference in mineralogical composition just noted might well be explained on the basis of differences in conditions of cooling and crystallization where the molten syenite was so thoroughly involved with the Grenville and its associated igneous rocks. Contact metamorphic effects must have been common and portions of the Grenville may at times have been absorbed by the molten syenite.

Another common type ranges from gray and dark gray to almost black, the color depending upon the biotite mica content, which is often very high. Other minerals which may be present are anorthoclase, oligoclase, quartz and smaller amounts of magnetite or hornblende. Rocks of this type usually appear as dark bands within the syenitic masses.

Other rocks ranging from light to dark color and containing garnets are thought to be Grenville, but they are so closely involved with other masses that they can not be mapped. Such a light colored feldspar rock with large garnets occurs along the railroad about 2 miles northeast of Anos Siding.

Another rock generally classed with the Grenville is rich in sillimanite and sometimes occurs in the complex as for instance at Forestport.

A rock type rich in hornblende and black in color occurs in distinct bands in the complex. A rock of this same character is found in the Grenville and was considered to be an old metamorphosed gabbro. Besides hornblende the rock contains feldspar ranging from oligoclase to labradorite and a little magnetite.

Another rock often present in very irregular masses and apparently cutting through all the others is a pegmatite. It is generally coarse grained and not in distinct veins.

All sorts of gradations occur between the types here described and these rocks in turn often grade into either the syenite or the Grenville masses proper.

Undetermined Precambric areas. Two areas have been indicated upon the geologic map as Precambric but of unknown character, because the rock masses are completely concealed from view by heavy glacial drift deposits. The area between Forestport and Enos is probably mostly made up of the Syenite-Grenville complex because those rocks bound the area both on the north and on the south. The area between West Canada creek and Little Black creek probably is syenite on the west and Syenite-Grenville on the east.

Paleozoic rocks

Potsdam sandstone and Beekmantown limestone. The Potsdam sandstone, which is the oldest of the Paleozoic formations bordering the Adirondacks, is certainly nowhere present at the surface within the map limits. There is evidence for believing that this sandstone is present along the southwestern border of the Adirondacks under cover of later formations. This question has been carefully discussed by Professor Cushing in his report on the Little Falls district.[1]

It is also true of the Beekmantown limestone that no exposures occur within the map limits. At Little Falls the Beekmantown (Little Falls dolomite) is something like 400 feet thick, but it shows a rapid thinning both northward and northwestward. In the vicinity of Cold Brook and Poland, and only a little over a mile from the southern boundary of the Remsen quadrangle, a considerable thickness of Beekmantown is shown. Thus, more than likely, it extends northward under the younger formations for a short distance at least on the Remsen quadrangle.

The Beekmantown comes close to where Black creek enters the map limits, but it seems to have disappeared before that point was reached. There is no evidence whatever to suggest the presence of Beekmantown in the northwestern part of the district.

Trenton formation. As here discussed the Trenton formation includes the Lowville limestone at the base, then possibly the Black River limestones and shales, with the Trenton limestone proper at the top.

The Lowville limestone shows in outcrop within the map limits only in the northwest along Black river. The outcrops are in the bed of the river and are well shown a short distance above the mouth of Crystal creek. The rocks are fine grained, compact, of a light bluish gray color and show many of the calcite filled tubes so characteristic of the formation. The layers are generally from 6 inches to a foot thick and constitute a very pure limestone. The exposed thickness of the Lowville here is about 10 or 12 feet and although neither the top nor the bottom is visible the maximum thickness can not be much over 30 feet. At the mouth of Crystal creek there is a Precambric outcrop only a few rods from the Lowville,[2] and a short distance west Trenton limestone is exposed.

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[1] Geology of the Vicinity of Little Falls. N. Y. State Mus. Bul. 77. 1905.

[2] Along the western border of the Adirondacks the Lowville rests unconformably upon the Pamelia formation of Cushing. The Pamelia has been traced across the Port Leyden quadrangle by the writer and it is possible that just a trace of it may be present between the Precambric and the Lowville at Crystal creek.

Many outcrops of the Lowville may be seen extending along Black river from the locality here described to the type locality at Lowville. Just below the mouth of Crystal creek some of the limestone layers are clearly ripple marked. From trough to crest the ripples are usually less than an inch in hight, while from crest to crest the distance is only 1 or 2 inches.

The Lowville is nowhere exposed in the southern portion of the region, although a few miles off the map limits and between the villages of Newport and Poland, along West Canada creek, a thickness of over 20 feet may be seen.[1]

The Black River formation of the southwestern Adirondacks consists of a few feet of alternating limestones and shales lying between the Lowville and the Trenton, but not always present. Actual outcrops of the Black River are nowhere visible within the region here described, although the formation is probably present to a greater or less extent under cover of the Trenton proper. A few miles south of the map limits and along West Canada creek, between Newport and Poland, about 7 feet of Black River limestone and shale may be seen resting upon the Lowville. It also occurs at several localities within the Little Falls district.

Towards the northwest and a few miles off the map the Black River formation outcrops along Black river. Within the map limits, as above stated, the actual contact between the Lowville and Trenton opposite the mouth of Crystal creek can not be seen because of drift covering. Thus a thin layer of the Black River may possibly be present there.

The Trenton limestone proper occupies by far the largest territory or more than one third the area of the whole quadrangle. With the exception of the small Lowville area above described the Trenton rocks are thought to overlap everywhere upon the Precambric. In general this formation may be said to be made up of thin bedded, dark bluish gray, compact limestones separated by thin shaly layers, except the upper 25 to 35 feet which consists of thicker bedded, gray, coarse crystalline limestones with thin shaly partings. These rocks are everywhere highly fossiliferous, the limestone layers at times being made up almost entirely of shells.

The type locality for the Trenton limestone is along West Canada creek, at Trenton Falls, in the southern portion of the region under

[1] Prosser & Cumings. Sections and Thickness of the Lower Silurian Formations on West Canada Creek and in the Mohawk Valley. N. Y. State Geol., 15th An. Rep't. 1898. p. 628–29.

discussion. The most complete continuous section of the formation is here shown, which according to Prosser and Cumings has a measured thickness of 270 feet with neither top nor bottom exposed. The work of the writer to the west and northwest of Trenton Falls shows that the upper coarse crystalline beds are nowhere much over 35 feet thick and that the Utica shale rests directly upon these beds. Hence the uppermost beds of the Trenton Falls section must be within a few feet of the actual top of the Trenton.

The bottom of the Trenton is also not shown at Trenton Falls, although the dip of the strata and the presence of Beekmantown and Lowville limestone a few miles to the southeast make it appear very probable that the lowest beds at Trenton Falls must be close to the bottom. Allowing for the necessary addition to the top and the bottom, the thickness of the complete section at Trenton Falls is at least 280 feet and probably not more than 300 feet. In the section of the Globe Woolen Mills well at Utica the Trenton shows a thickness of 510 feet, while in the Rome well the thickness is given as 375 feet. Thus the Trenton shows a greater thickness both to the southward and the southwestward.

Because of the importance of the Trenton Falls section a somewhat detailed description is here given, although many more details may be found in the writings of Vanuxem,[1] Darton,[2] T. G. White,[3] Prosser and Cumings,[4] and Clarke.[5]

For 2½ miles between the villages of Prospect and Trenton Falls, West Canada creek has cut a deep narrow gorge through the Trenton limestone. This gorge, with nearly vertical walls, varies in depth from 100 to about 200 feet and is commonly known as "Trenton chasm." In all there are six waterfalls varying in hight from a few feet to 128 feet. The principal falls are: Sherman fall, about 30 feet high and a short distance above the power house; High falls (¼ mile south of the railroad bridge) consisting of an upper and a lower part with a total fall of 128 feet; the falls at the dam (just north of the railroad bridge) about 40 feet high; and Prospect falls (at the upper end of the gorge) 25 or 30 feet high. According to the topographic map the total drop of the stream within the 2½ miles is about 360 feet. At the time of high water especially, the falls present magnificent sights. In spite of the steep slope of the

[1] Vanuxem, L. Geol. N. Y. 3d Dist. 1842. p. 45–56.
[2] Darton, N. H. N. Y. State Geol. 13th An. Rep't. 1894. 1:616–23.
[3] White, T. G. N. Y. Acad. Sci. Trans. 1895–96. 15:71–96.
[4] Prosser & Cumings. N. Y. State Geol. 15th An. Rep't. 1898. 1:615–27.
[5] Clarke, J. M. U. S. N. Y. Hdbk 15. 1899. p. 64–67.

Plate 1

View of the "Narrows," from lower end, with Sherman fall in the distance. The zone D^4, of White, well shown on the left bank. Lower Trenton limestone.

Plate 2

N. H. Darton, photo.

Lower Trenton limestone, Sherman fall, Trenton Falls, Oneida co.

Plate 3

High fall, showing both the lower and upper parts. Middle Trenton limestone

stream bed the southward dip of the strata permits an exposure of only 270 feet of the rocks.

The lower Trenton limestones are dark bluish gray, thin bedded and fine grained with occasional coarser grained layers interstratified. Thin shale partings are nearly always present. On account of the dip the lowest beds are not found at the end of the gorge, but in the "Narrows" just above the power house. According to Prosser and Cumings[1] these rocks contain the following fossils:

1 Monticulipora (Prasopora) lycoperdon (*Say*)
2 Diplograptus amplexicaulis *Hall*
3 Trematis terminalis (*Emmons*) *Hall*
4 Rafinesquina alternata (*Con.*), *Hall & Clarke*
5 Strophomena *cf.* scofieldi *Winch. & Schuch.*
6 Orthis (Platystrophia) biforata (*Schl.*) *Bill.*
7 O. (Dalmanella) testudinaria *Dal.*
8 Plectambonites sericeus (*Sow.*) *H. & C.*
9 Zygospira recurvirostra *Hall*
10 Bellerophon bilobatus (*Sowerby*)
11 Asaphus platycephalus *Stokes*
12 Calymmene callicephala *Green* = C. senaria *Con.*
13 Ceraurus pleurexanthemus *Green* (?)
14 Crinoid segments

The middle Trenton limestones are mostly dark bluish gray, thin bedded, compact and with pronounced shale partings. According to Prosser and Cumings the middle Trenton fossils include:

1 Monticulipora (Prasopora) lycoperdon (*Say*)
2 Stictopora *sp.*
3 Rafinesquina deltoidea (*Con.*) *H. & C.*
4 Orthis (Platystrophia) biforata (*Schl.*) *Bill.*
5 O. (Dalmanella) testudinaria *Dal.*
6 Plectambonites sericeus (*Sow.*) *H. & C.*
7 Tellinomya dubia *Hall*
8 Endoceras proteiforme *Hall*
9 Cyrtoceras *sp.*
10 Asaphus platycephalus *Stokes*
11 Crinoid segments

The upper Trenton limestones are also dark bluish gray, thin bedded, and divided by shaly partings. The more compact strata are frequently interstratified with others which are somewhat crystalline. The upper 26 feet are light gray, coarse grained, crystalline limestones in thick beds which are separated by very thin shale partings. These coarse grained rocks are full of fossil fragments and are best exhibited in the quarries

[1] *Op. cit.* p. 622–23.

below Prospect. According to Prosser and Cumings the list of fossils includes:

1 Monticulipora (Prasopora) lycoperdon (*Say*)
2 Escharopora recta *Hall*
3 Trematis terminalis (*Emmons*) *Hall*
4 Rafinesquina alternata (*Con.*) *H. & C.*
5 R. alternata *var.* nasuta *Con.*
6 R. deltoidea (*Con.*) *H. & C.*
7 Strophomena *cf.* scofieldi *Winch. & Schuch.*
8 Orthis (Platystrophia) biforata (*Schl.*) *Bill.*
9 O. (Dalmanella) testudinaria *Dal.*
10 Plectambonites sericeus (*Sow.*) *H. & C.*
11 Zygospira recurvirostra *Hall*
12 Asaphus platycephalus *Stokes*
13 Calymmene callicephala *Green*
14 Ceraurus pleurexanthemus *Green*
15 Leperditia fabulites *Con.*
16 Endoceras proteiforme *Hall*
17 Orthoceras *sp.*
18 Bellerophon bilobatus (*Sowerby*)
19 Dendrocrinus gracilis (*Hall*)
20 Murchisonia gracilis (*Hall*)
21 Stictopora *cf.* acuta *Hall*
22 Crinoid segments

Highly contorted strata between undisturbed strata may be seen between the lower and upper portion of High fall, and also along the footpath especially opposite the crest of High falls. These phenomena will be discussed later under a separate heading.

Another Trenton section ranking next in importance to the one just described is that at Gravesville and extending from the village for more than a mile up Mill creek. A thickness of nearly 200 feet is here shown with neither top nor bottom exposed.

At Grant and extending for a half mile down Black creek a good section (20 to 30 feet) of lower to middle Trenton beds may be seen.

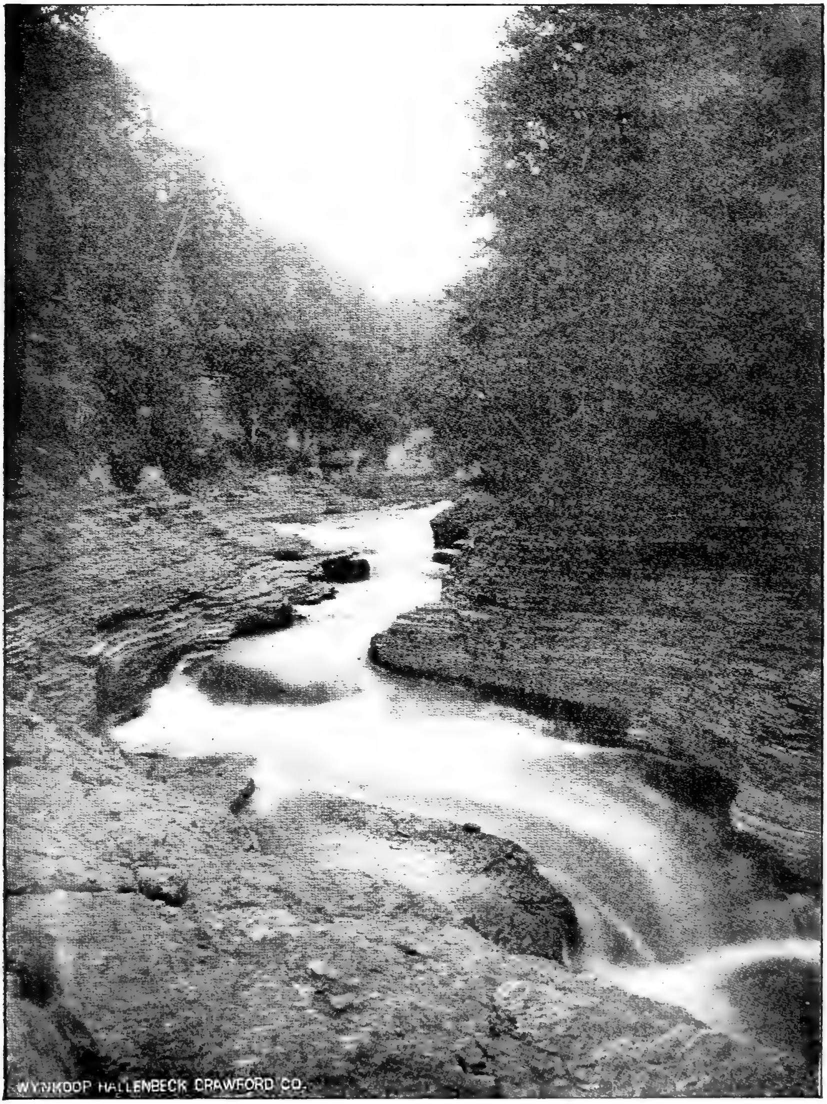
The upper Trenton limestones are well shown at Hinckley; between Trenton and Holland Patent; north and northeast of Steuben Valley; along Town Line (Cincinnati) creek from Prospect station (R. W. & O.) to Remsen; in the vicinity of Honnedaga and Bardwell Mill; and south of Alder Creek station. Besides these many smaller outcrops were found.

The upper, gray, coarse crystalline beds form the surface rock (largely covered by glacial drift) over most of the western portion of the Trenton limestone area. They are especially well shown near the Utica shale contact line.

Dolgeville (upper Trenton) shales. A series of alternating thin bedded limestones and shales, lying between the Trenton proper and the Utica shale, and found in the Little Falls district is called by Cushing the Trenton-Utica Passage Series.[1] Recently, however, Cushing has proposed the name Dolgeville (upper Trenton) shales

[1] *Op. cit.* p. 31–32.

Plate 4



N. H. Darton, photo.

Upper gorge, Trenton Falls, Oneida co. Upper Trenton limestone

Plate 5

Cliff on the east side of West Canada creek above the Adirondack Railroad bridge. The massive crystalline limestone is shown in the upper part of the cliff. Upper Trenton limestone

for these beds.[1] These rocks are absent from the Trenton Falls region except probably to a small extent in the extreme southeastern portion. They are mapped as occupying the extreme northwestern corner of the Little Falls quadrangle and hence would extend over, to a greater or less extent, upon the Remsen quadrangle. It is highly probable that these rocks are thus present although outcrops are nowhere shown because this region is so deeply covered by glacial drift as to completely conceal all underlying formations. The rocks of this series are transitional in character, the limestone layers being very similar to the Trenton while the shale layers are very similar to the Utica shale.

The Utica shale formation. The Utica shale, wherever present, rests directly upon the coarse crystalline beds of the upper Trenton. From the lithologic standpoint the formation is remarkably uniform and free from limestone or sandstone beds. The shale is black, thin bedded to even laminated, and because of its hardness and easy splitting is often popularly miscalled "slate." As seen upon the geologic map the shale is entirely confined to the western part of the quadrangle where it occupies most of the area west of the R. W. & O. Railroad.

The contact between the shales and the upper, coarse grained beds of the Trenton is a very sharp one although the lowermost beds of shale are more or less calcareous, thus showing that the change from limestone to shale is not so abrupt as the outward appearance of the rocks seems to indicate. The two formations may be seen in close proximity at several places along the stream beds to the north and northeast of Steuben Valley. Perhaps the best locality for observing the contact is along the railroad (R. W. & O.) about $\frac{3}{4}$ of a mile north of East Steuben station, where the shale and the coarse grained limestone are within 1 or 2 feet of each other. Beyond the map limits to the south, the sharp contact is well shown in the bed of Nine Mile creek, $1\frac{1}{2}$ miles southeast of Holland Patent. A low anticline here brings up the upper Trenton limestone with Utica shale resting on either limb.

The typical Utica shale beds extend well up on the sides of Starr hill where they reach an elevation of about 1560 feet. The lowest shale beds east of Starr hill lie at about 1250 feet. Hence the thickness of the Utica shale here must be something over 300 feet. A

[1] Since the appearance of the Little Falls report it has become evident that the formation therein mapped as "Trenton-Utica passage beds" is in reality a shaly eastern representative of the upper Trenton limestone of the type section, as I suggested at the time [N. Y. State Mus. Bul. 77, p. 63–64]. It seems also that this division is separable from the Trenton and Utica as a lithologic unit throughout the Mohawk valley. For this shaly phase of the upper Trenton I propose the name of Dolgeville shale, the full thickness with both contacts being exposed in the banks of East Canada creek just below Dolgeville. [*Signed*] H. P. Cushing

thickness of approximately 600 feet in the southern part of the Little Falls district is given by Cushing. The record of the Campbell well near Utica shows 710 feet of the shale there. The deep well at Rome shows a thickness of only 300 feet of shale. Thus there seems to be a notable thinning of the Utica shale in passing northwestward.

Lorraine beds. The Lorraine beds of the Hudson River group appear at only one place within the map limits, namely at the top of Starr hill. The beds there show a thickness of about 200 feet with the top not reached. As is usually the case in central New York these lower beds appear to be destitute of fossils. Penn mountain and other high hills just west of the Remsen quadrangle are capped by the same formation.

There is no sharp line of demarcation between the Utica and the Lorraine and thus an exact boundry line can not be drawn. Passing upward the Utica black shales give way to generally lighter colored, rather more sandy shales containing frequent thin beds of gray sandstone. At times, however, the Lorraine shales closely resemble the Utica shales. Good exposures may be seen on the western side of Starr hill and also near the top of Penn mountain at about the 1700 foot level.

STRUCTURAL FEATURES

Folds

The Paleozoic formations show a very perceptible southwesterly dip but it is by no means uniform. For instance to the north of Remsen and in the vicinity of Honnedaga the limestone beds show very little departure from horizontality, while to the north of Steuben Valley they show a dip of approximately 100 feet per mile to the southwestward. Again in the bed of Mill creek, about a mile above Gravesville, the limestones show a very sharp dip of 15° to the southwest. In other cases the southwestward dip is just enough to be noticeable in the outcrops. Thus we see that strata which in a given locality lie almost horizontal may within a short distance show a comparatively steep dip giving rise to low folds whose axes extend northwest and southeast.

Another set of folds whose axes extend northeast and southwest are also more or less clearly distinguishable. Such are the folds accompanying the Trenton fault and fold (below described). A low anticlinal fold with similar strike has been observed to the northeast of Steuben Valley where along one stream the limestone

clearly dips to the west while along another stream a mile east the dip is southeastward. In the stream bed below Grant the limestone clearly dips northwestward thus suggesting the limb of a similar fold there. Off the map limits, about 2 miles southeast of Holland Patent and in the bed of Nine Mile creek, a very distinct anticline with northeast-southwest strike is exposed. The upper Trenton is here brought to view with shale dipping away on either side.

Aside from these larger folds numerous small ones occur, as for example in the bed of West Canada creek at Trenton Falls village.

Faults

Trenton fault and fold. A line of distinct faulting and folding passes from near Prospect village for 9 miles southwestward to

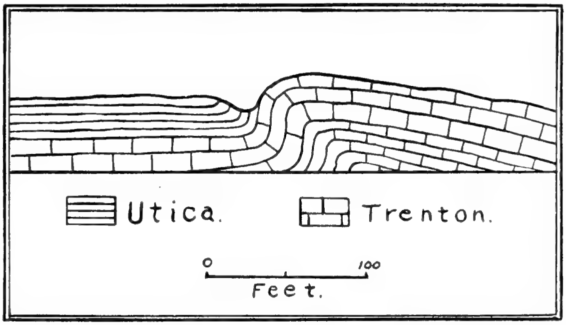


Fig. 1 Section across the line of sharp folding $2\frac{1}{2}$ miles southwest of the village of Trenton. The minor faulting is not shown in the drawing.

Stittville beyond the map limits. The line of disturbance is almost straight and beginning east of Prospect, it passes near Prospect station (R. W. & O. R. R.), just west of Trenton, thence off the map through Holland Patent and to Stittville. That portion of the line between Trenton and Holland Patent has been very briefly described by Darton,[1] but the more important part lying between Trenton and Prospect is here described for the first time. The writer has called the whole line of disturbance the Trenton fault because it passes through the town of Trenton. The Trenton fault is of interest for several reasons: because it is the most westerly of all the series of Mohawk valley faults yet described; because it is the only one of the series which shows thrust faulting; and because it is one of a very few which have the downthrow side on the west. Two other faults of the series having downthrow on the west are the Dolgeville fault and the branch of the Little Falls fault.

[1] N. Y. State Geol. 14th An. Rep't. 1895. p. 52–53.

Between Trenton and Holland Patent the disturbance has manifested itself chiefly as a sharp anticlinal fold with a steep western front accompanied by comparatively slight faulting. The above figure shows the condition of things here according to the writer's conception.

According to Darton[1] normal faulting has been the principal cause of the displacement and as a result of slipping, the Utica shales, on the downthrow side, have been bent upward while the limestone beds on the upthrow side have been bent downward. According to him the upper Trenton has been sharply faulted against the Utica, the amount of displacement being possibly as much as 60 feet. A careful study of the limestone-shale contact has failed to reveal any such sharp or extensive faulting as suggested by Darton. According to the writer the steep dips of the limestone and shale are due entirely to the development of an anticline whose western limb is very steep and sometimes nearly vertical so that it approaches the overturned type. As a result of the folding and later removal of shale by erosion the limestone beds do appear displaced or raised above the level of the shale The difference in level is often 40 to 60 feet as Darton suggests but it is not due chiefly to faulting.

If the lateral pressure which formed the anticline had continued, a typical overturned fold and finally a thrust fault would have developed. As it is, the only evidence of faulting is within the body of the limestone itself, near the shale contact, where small thrust faulting may occasionally be seen. All along the line between Holland Patent and Trenton the harder, more resistant limestone beds stand out as a low sharp ridge while the softer shales on the west have been worn down.

In the vicinity of Prospect station 1½ miles southwest of Prospect there is also abundant evidence of disturbance. Here, however, upper Trenton limestones only are present. Along the small streams just north of the station they are seen to be strongly folded, in one case the limestone beds standing in vertical position. Also to the west of the station in the bed of Cincinnati (Town Line) creek the limestone beds are much disturbed by folding. In this vicinity some minor faulting has been noted although for most part the disturbance shows itself in the folding.

Between Prospect station and Prospect village the country is deeply drift-covered, while at Prospect occurs the principal disturbance visible along the line. A thrust fault of considerable

[1] *Op. cit.* p. 52–53.

Plate 6

W. J. Miller, photo.

Looking westward and parallel to the strike of the fault at Prospect. On the right are thick beds of the upper Trenton; on the left are highly inclined, thin bedded middle Trenton strata; while between are broken and crushed middle Trenton rocks. The water's edge on the right lies along the fault plane.

throw is clearly exhibited in the creek bottom between Prospect falls and the highway bridge. The topographic map is here not accurate in detail and the following sketch map will give a better idea regarding the location of the fault.

Before reaching the falls the stream flows due west and at the falls makes a sharp turn to flow about 200 yards east-southeast till the fault line is struck. At the latter point another sharp turn is

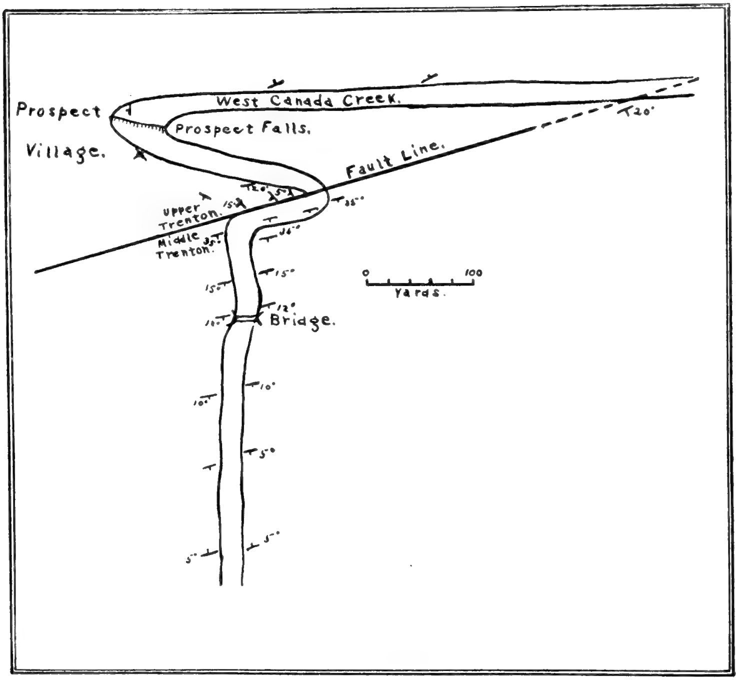


Fig. 2 Sketch map showing the course of West Canada creek and the position of the fault near the village of Prospect

made so that the stream flows west-southwest for 50 or 60 yards, and parallel to the fault line. Then the course of the stream is due south to the highway bridge. Where the creek flows parallel to the fault line the fault plane is clearly exposed and in reality forms the north bank of the creek [*see* pl. 6 and 7]. The strike of the fault is n. 70° e. and the dip of the fault plane is 55° to the south. It is a thrust fault with the downthrow side on the north [*see* fig. 3]. The rocks on the downthrow side are the thick bedded, coarse crystalline limestones belonging at the summit of the Trenton formation. These rocks form a bold rocky point extending

eastward to the creek and they show variable dips of from 5° to 15° a little to the south of west. The rocks in the creek bed on the upthrow side of the fault are middle Trenton limestones. A short distance away from the fault plane these rocks are highly inclined showing a uniform maximum dip of 35° a little to the east of south. Continuing southward to the bridge higher and higher Trenton strata are seen and the dip gradually diminishes to 12°. Below the bridge the dip continues to decrease until finally at about 150 yards the strata lie in a horizontal position and the coarse limestone of the uppermost Trenton is visible at the top of the gorge. Still farther southward the rocks dip northward at a low angle.

In the immediate vicinity of the fault and on the upthrow side the rocks are highly crushed and folded. This crushed zone is

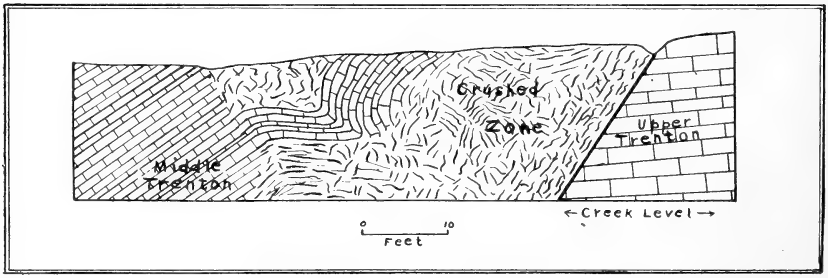
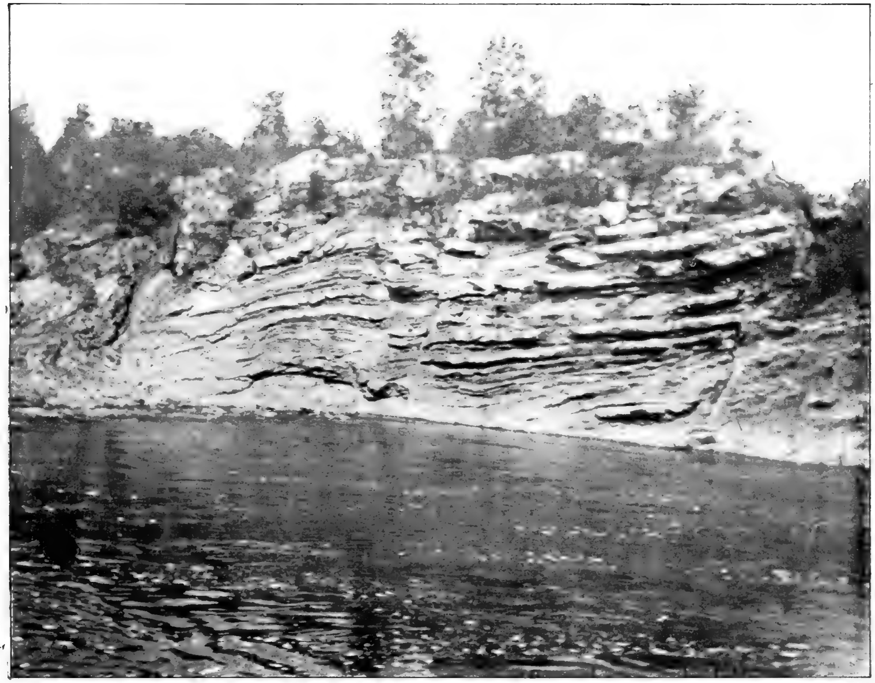


Fig. 3 Section showing the condition of things at the fault near Prospect. Looking southwest and parallel to the fault plane

about 40 feet wide [*see* fig. 3]. The rocks on the downthrow side are not crushed and the fault plane is shown as a smooth clean break [*see* pl. 7]. Along the fault plane slickensides are common and also fault breccia made up of limestone fragments which have often been recemented by white coarse crystalline calcite. On both sides of the main fault plane there are a number of fault slips of very small throw which represent minor fracturing in the immediate vicinity of the main fault. Except for a slight southwestward dip the strata at Prospect falls show no sign of disturbance.

Because of the existence of the wide crushed zone on the upthrow side the character of the folding in that zone can not be determined. Hence the exact throw of the fault can not be given although it can be fairly well approximated. As a result of the faulting the beds of the middle Trenton have been brought up to the level of the coarse crystalline beds of the upper Trenton and hence the fault must be of the thrust or reversed type. A measurement by the

Plate 7



W. J. Miller, photo.

Looking north upon the fault plane at Prospect. Except at the extreme left, the whole rock surface shown is that of the fault plane itself. The dark streak near the left margin and nearly under the small dead tree represents the contact between the crushed middle Trenton and the heavy bedded upper Trenton.

writer of the thickness of the upturned strata from the base of the coarse crystalline beds to the crushed zone at the creek level near the fault plane gave 140 feet. This result corresponds to within a few feet of the thickness obtained by Prosser and Cumings for the same set of strata farther down the gorge. According to those authors the conspicuously contorted stratum opposite the top of the lower fall of High fall occurs just above their zone A^5 or 144 feet below the top of the Trenton. This same contorted stratum has been traced by the writer to near the fault and between it and the fault there intervenes a thickness of 25 or 30 feet of still lower strata. It is evident therefore that the beds as low at least as the upper part of Prosser and Cumings zone A^5 are thrown by faulting against the gray crystalline upper Trenton beds. Thus the stratigraphic throw of the fault (disregarding the crushed zone) is something like 140 feet. The throw or vertical displacement is probably from 30 to 50 feet greater than the stratigraphic throw. Because of the high angle of dip of the fault plane the heave (horizontal displacement) must be considerably less than the throw.

Upturned strata are often present among the shales on the downthrow sides of the Mohawk valley faults. They are due to an updragging effect produced by normal faulting. At the Trenton fault, however, the strata are upturned on the upthrow side and were bent upward by the lateral pressure which first probably developed a fold and later a fracture so that the middle Trenton rocks were pushed upon the upper Trenton.

Where the fault line would be expected to cross the creek about $\frac{1}{4}$ of a mile eastward the only sign of disturbance is a small but very distinct fold in the limestone beds. Thus the fault above described dies out so rapidly that within the $\frac{1}{4}$ mile it is entirely gone and passes into a small fold. Beyond this the line of disturbance can not be traced because of heavy drift deposits.

Minor faults. A number of small faults have been noted along the gorge between High fall and Prospect but the throw is always slight. The Trenton rocks have been considerably disturbed by folding and faulting on Mill creek and one of its tributaries about a mile above Gravesville. Sharp folding is well shown where the line crosses Mill creek (at the mill), while folding accompanied by faulting of unknown though small extent is exhibited where the line crosses the tributary (the second one above Gravesville) a quarter of a mile above its mouth. This line of disturbance strikes n. 70° w. and it can not be traced across country.

Dip of the Paleozoic formations

As the Paleozoic rocks were originally laid down nearly horizontally movements since their deposition have caused them to have a general southwestward dip. The amount of the dip is usually small and may be clearly demonstrated by comparing the altitude of given horizons within the Trenton at different places.

At Trenton Falls the top of the Trenton limestone is 1100 feet above sea level, while the same horizon was struck at 142 feet below sea level in the Globe Woolen Mill well at Utica. Thus the difference in elevation of the same horizon between these points 14 miles apart is 1242 feet, showing a southward dip of 90 feet per mile.

Again, the top of the Trenton 1 mile south of Alder Creek station is at 1280 feet, while the same horizon in the Rome well is 205 feet below sea level. The difference in elevation is 1485 feet and the distance is 18 miles, which shows a dip of 82 feet per mile for the limestone.

At Grant, lower Trenton is exposed at 1200 feet, while at Gravesville 5 miles to the southwest the same beds lie at 900 feet, thus giving a dip of 60 feet per mile.

The difference in elevation between the top of the Trenton at Bardwell Mill and Remsen, which places are 4½ miles apart is approximately 40 feet, thus giving a dip of 9 feet per mile.

Over the western part of the town of Remsen the strata must lie almost horizontal as shown by the outcrop of the upper Trenton over such an area at practically the same elevation.

Uppermost Trenton beds are shown at Remsen and also at a point 1¼ miles northeast of Steuben valley. The distance between these points is 2½ miles and the difference in elevation is about 250 feet, so that here the southwestward dip is about 100 feet per mile.

Certain marked variations from this general southwestward dip due to the development of the Trenton fault and fold have already been described.

Joints

The Precambric rocks are everywhere highly jointed and the joint planes are always vertical or at high angles. After many observations the writer has not been able to make out any well defined system. Even over short distances the directions are very variable. Locally, however, two well developed joints may generally be seen crossing each other at rather high angles. Besides these other minor and irregular joints are present.

The Paleozoic rocks, too, are thoroughly jointed and, as in the case of the Precambric rocks, these joints are mostly nearly verti-

cal. Although these joints show great variation in direction and degree of development, nevertheless over most of the Paleozoic area two sets running approximately east-west and north-south appear to predominate. These are particularly well seen in the vicinity of Trenton Falls and Remsen. The vertical walls of the gorge at Trenton Falls are principally due to the breaking away of large limestone masses along the north-south joint planes. The east-west joints may here be seen extending across the stream at many places, but especially at the falls themselves. The falls are all due to the existence of the joints since when a large mass of limestone is removed a vertical wall is left over which the water falls. Thus the falls retreat and reform by the removal of joint blocks as, for example, in the case of Sherman fall. Here at high water the water falls over one joint plane on the eastern side and over another a number of feet back on the west side. When the water is low it all passes over the rear joint on the west [*see* pl. 2]. It is very evident that, in the course of time, the whole block of limestone left between the two joints will be removed.

In the bed of Cincinnati (Town Line) creek, from 1 to 1½ miles below Remsen an interesting drainage feature is due to the joint planes in the coarse crystalline (upper Trenton) limestones. Several hundred yards above the bridge, at time of low water, the stream disappears entirely through the joints and after a subterranean course, mostly along the joints, it reappears near the bridge.

Foliated structure

A foliated or gneissic structure is highly characteristic of all the Precambric rocks. It is exhibited best of all in the ancient Grenville sediments, next best in the rocks of the Syenite-Grenville complex, and least in the pure syenite. The excessive foliation of the Grenville is accentuated by the alternating light and dark bands above described. The foliation of the syenite though distinct is brought out only by the dark, narrow, irregular, wavy streaks passing through the otherwise homogeneous rock mass.

As a result of many readings it may be stated that the Precambric foliation planes all show a strike varying between n. 60° e. and n. 80° e. This result agrees closely with that obtained by Cushing for the Little Falls quadrangle and for the Long Lake quadrangle of the mid-Adirondacks. The dip of the foliation planes is sometimes north and sometimes south but nearly always at very high angles. Often the Grenville and the Syenite-Grenville complex rocks are locally highly plicated or crumpled

It is interesting to note that the strike of the Trenton fault and fold, as well as the strike of a number of low folds within the region corresponds closely to the strike of the Precambric foliation planes. This shows that the pressures so different in intensity and which produced both sets of phenomena so widely separated in time, acted in the same direction.

Contorted strata within the Trenton [1]

Excellent examples of highly folded or contorted strata between nonfolded strata may be seen along the sides of the gorge at Trenton Falls. Dr J. M. Clarke has called the writer's attention to a similar case of interbedded contorted limestones described by Sir

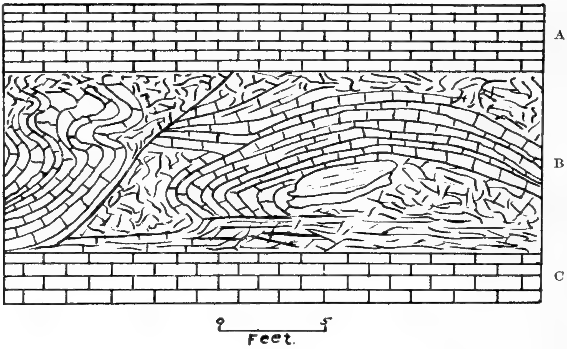


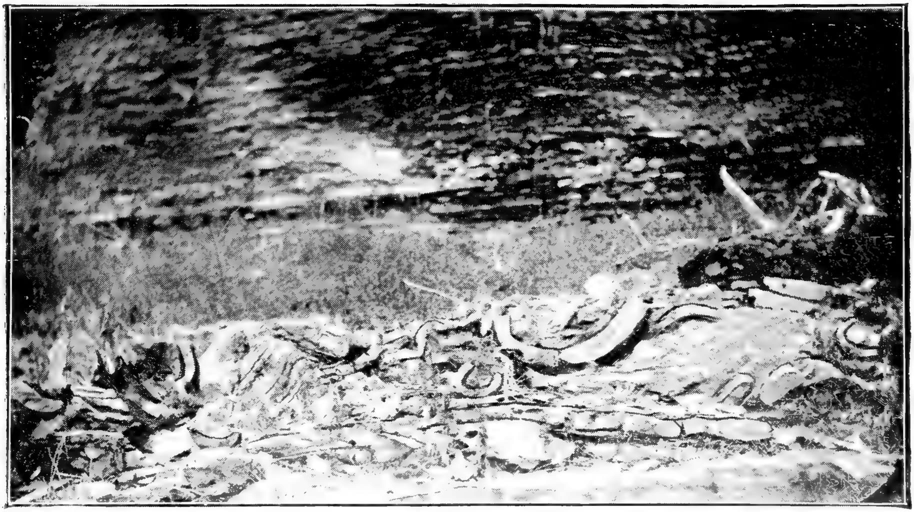
Fig. 4 Highly folded and broken strata between nonfolded strata as seen along the footpath opposite the crest of High falls. Drawn from nature

William Logan[2] and occurring on the Forillon peninsula of Gaspé, along the Gulf of St Lawrence. According to Clarke[3] these contortions lie in the Cape Bon Ami beds of the lower Devonic.

At Trenton Falls the folded beds lie at two distinct horizons within the Trenton limestone. According to Prosser and Cumings[4] who have made careful measurements of the thickness of the limestone at this locality, the base of the lower contorted zone lies 144 feet below the top of the Trenton. This zone is from 4 to 6 feet thick and is visible only at the crest of the lower part of High fall and in the upper end of the gorge near Prospect where the strata are highly inclined [*see* pl. 8]. Using the measurements of Prosser and Cumings the base of upper folded zone lies about 65 or 70 feet

[1] *See* paper by the writer in Jour. Geol. 1908. 16:428–33.
[2] Geol. Can. 1863. p. 391–92.
[3] N. Y. Mus. Mem. 9.
[4] N. Y. State Geol. 15th An. Rep't, p. 615–27.

Plate 8



T. G. White, photo.

The lower contorted and broken zone as seen near the crest of the lower part of High fall (From N. Y. Acad. Sci. Trans. v. 15, pl. III, fig. A)

below the top of the Trenton. This zone varies from about 8 to 15 feet in thickness and is well shown along the path opposite High fall. From this point it may be traced along the sides of the gorge for nearly 2 miles to Prospect village.

The impure limestone layers of both the folded and the non-folded portions average only a few inches in thickness and are separated by thin shale bands. Within the folded zones the layers are, in rare instances, scarcely folded or broken; sometimes they are gently folded; most commonly they are highly folded or contorted; while occasionally some of the layers are broken and pushed or faulted over others.

Numerous observations show the strike of the folds to be from n. 50° e. to n. 65° e. or practically parallel to the strike of the Trenton fault and also parallel to the very low folds of the Trenton limestone in this region.

It should be noted that these contorted strata occur only in a very local district. As far as can be ascertained they are visible only in the Trenton Falls gorge and in the bed of Cincinnati creek, 1½ miles southwest of Prospect. Along Mill creek, above Gravesville, the contorted strata do not show in the excellent Trenton section there exposed.

Cause of the folding. Vanuxem[1] states that the folded layers are more thoroughly crystalline than the layers above and below and that as the material of the disturbed layers was being crystallized it caused an expansion which manifested itself laterally by throwing the layers into folds. However a careful study has failed to show any real difference in degree of crystallization and even if such difference could be found it is difficult to see how simple crystallization could bring about such a considerable expansion.

T. G. White[2] cites Prof. W. O. Crosby as suggesting that the folds may have been caused by the great weight of overlying strata. But this does not explain the sharp and even overturned folds and minor thrust faults which imply a distinct shortening of the layers within the folded zones.

In some places the structure greatly simulates cross-bedding. White[3] gives photographs showing supposed overlap structure and channel filling. Since these structures are associated in the same zone, with truly folded and broken strata some other explanation must be sought.

[1] Geol. N. Y. 3d Dist. 1842, p. 90.
[2] N. Y. Acad. Sci. Trans. 15:89–90.
[3] *Op. cit.* pl. 3, fig. B and pl. 4, fig. B.

It has occurred to the writer that the cause may have been a lateral compression which caused most of the limestone beds to become denser without being folded, while certain other layers yielded by folding. This would seem to imply a greater rigidity for the folded zones, but if anything the evidence points to less rigidity.

Regarding the Canadian occurrence above referred to Logan says: "It would appear as if the layers after their deposit had been contorted by lateral pressure, the underlying stratum remaining undisturbed, and had then been worn smooth before the deposition of the next bed. Where the inverted arches of the flexures occur some of the lower layers are occasionally wanting, as if the corrugated bed had been worn on the under as well as the upper side." But it is difficult to see how such a lateral pressure could cause certain layers to become highly folded and broken while the layers immediately below them are undisturbed. Also the apparently worn character of the upper and lower sides, mentioned by Logan and which is likewise true of the Trenton Falls occurrence, is left without explanation.

It is thought that the folded structure at Trenton Falls was, in reality, caused by a differential movement within the mass of the Trenton limestone. That the whole body of the limestone has been moved is clearly demonstrated by the existence of the thrust fault at Prospect. It is easy to see how when the force of compression was brought to bear in the region there would be a tendency for the upper Trenton beds on the upthrow side to move more easily and consequently faster than the lower Trenton beds. For instance the portion A in figure 4 being separated from C by an intermediate mass B of slightly less rigidity, would slide over C and cause the portion B to become ruffled or folded. Occasionally parts of B would become fractured or faulted. A similar explanation would also apply to the lower folded zone. The folded zones thus merely indicate horizons of weakness along which the differential movement has taken place.

As thus explained it is evident why the strike of the minor folds, the strike of the fault, and the strike of the large low folds of the region should all be parallel and why the contorted strata should be so local in occurrence, because all these phenomena were produced by the same local pressure. The differential movement would also readily account for the rubbed or worn character of the upper and lower sides of the contorted zone.

It is interesting to note that similar phenomena of contorted between nonfolded strata have been observed in clay banks of

Pleistocene age along Black river to the north of Trenton Falls and also along the Canal feeder west of Forestport. The latter occurrence has been described and figured by Vanuxem.[1] Regarding this phenomenon Vanuxem says: "No cause can reasonably be assigned but different degrees of lateral pressure." The folding is often so great, however, that the required differences in degree of lateral pressure are altogether too great. The writer believes that, in principle, the explanation given for the contorted limestones may apply here also, except in the case of the clay beds the movement of upper over lower masses may have been caused by ice action or by having been pulled down the hillside by gravity. Or as Salisbury and Atwood[2] have suggested for such a phenomenon in Pleistocene clay, that the cause may have been lake ice or "the grounding of an iceberg on the surface before the overlying layers were deposited." In any case the cause of the movement in these superficial clays is very different from that of the ancient Trenton limestones. Such interbedded contortions are very common in the Pleistocene clays of New York, especially along the Hudson river valley.

THE PALEOZOIC OVERLAP

As already stated the Paleozoic rocks overlap upon the Precambric. This was caused by a gradual sinking of the Adirondack region while Paleozoic deposition was going on, so that the younger formations encroached farther and farther upon the sinking land mass.

Since the Potsdam sandstone nowhere outcrops along the southwestern border of the Adirondacks, any evidence for its presence as the lowermost of these overlapping formations must be sought for in deep well sections. This question has been clearly discussed by Professor Cushing who uses data furnished by both Prosser and Orton.[3] The writer here merely wishes to state the general conclusion that in the Ilion, Utica and Rome wells the presence of Potsdam sandstone has not been definitely proved because of the difficulty in distinguishing Beekmantown and Potsdam on the one hand and Potsdam and Precambric on the other. Farther northward in certain Oswego county wells the presence of the Potsdam has been demonstrated. Since the Potsdam does not outcrop along the Precambric boundary line east of these wells it is evident that younger formations overlap it upon the Precambric.

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[1] *Op. cit.* p. 214–15.
[2] Jour. Geol. 1897. 5:143.
[3] Geology of the Vicinity of Little Falls. N. Y. State Mus. Bul. 77. 1905. p. 51–56.

Although the Beekmantown is not exposed within the map limits there is no question regarding its presence as an overlapping formation. In the northwest corner of the quadrangle, along Black river, the Lowville and Precambric are so close together as to preclude the presence of Beekmantown. Near the south boundary at Cold brook, the Beekmantown is exposed and doubtless extends northward under the Trenton. In the wells to the south and southwest at and near Utica and at Rome, the Beekmantown is present showing a thickness which is not accurately known, but which is quite certainly at least several hundred feet. Passing northwestward from these wells to the Precambric boundary the Beekmantown shows a diminution in thickness from several hundred feet to nothing, which is just what would be expected in the case of overlap.

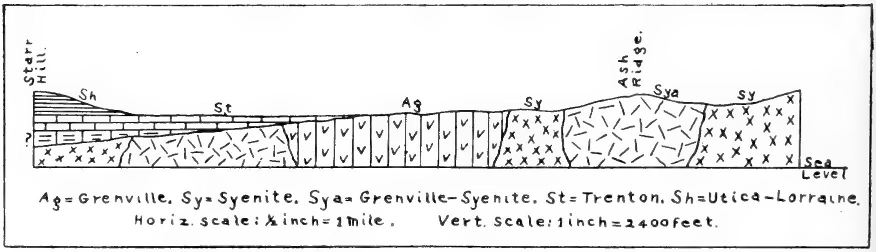


Fig. 5 Structural section across the region passing from Starr hill east-northeast and through Ash ridge

Within the map limits the Trenton formation, so far as can be determined, everywhere rests upon the Precambric, along the Precambric boundary. Along Black river, in the northwestern part of the quadrangle, the Lowville may be seen practically in contact with the Precambric. Thus the facts clearly show that the Trenton overlaps the Beekmantown upon the Precambric.

The Trenton shows a thickness of 510 feet in the Globe Woolen Mill well at Utica, 575 feet in the Chittenango well, and 435 feet (including the Lowville) in the Rome well. Within the Remsen quadrangle the maximum thickness of the Trenton including the Lowville is about 300 feet. Along the Precambric boundary there is strong evidence to show that the thickness of the Trenton is much less. Such evidence may be found along the line between Bardwell Mill, where upper Trenton is shown, and the mouth of Little Black creek where Precambric outcrops. When the difference in elevation and the greatest possible slope of the Precambric surface between these points are considered, it is evident that no

such thickness as 300 feet of limestone can here be present. In other words a well starting at the top of the Trenton at Bardwell Mill would strike the Precambric much short of 300 feet. The thickness of the Trenton here is probably not much over 150 feet. This thickness compared with the greater thickness at Trenton Falls and in the wells farther south and southwest is what would be expected in the case of an overlap.

THE PRECAMBRIC SURFACE

Smoothness of the floor upon which the Paleozoics were deposited

There is considerable evidence to show that the Precambric floor which received the Paleozoic sediments was a comparatively smooth one (peneplain). Although the exact boundary line between the Paleozoic and Precambric rocks can not be drawn because of the heavy drift covering, nevertheless there are sufficient exposures on either side to indicate that the line is at least a fairly regular one as shown upon the map. Such a boundary line would be caused by deposition of sediment upon a smooth surface and by later elevation when the sediments would tend to wear off rather regularly.

Or again the smoothness of the Precambric floor is suggested by the absence of isolated Paleozoic areas within the general Precambric district and also by the absence of isolated Precambric areas within the general Paleozoic district. If the Precambric floor had been a rough surface, isolated areas (outliers and inliers) would be expected, near the boundary line at least, where on the one hand sediments had been filled into deep Precambric depressions or on the other hand where Precambric knobs or hills would protrude upward into the sediment and by later erosion become exposed to view. Such outliers or inliers have nowhere been found.

If the depressions occupied by the present streams of the Precambric area were completely filled the resulting surface would be a comparatively smooth one sloping southwestward. This strongly suggests that the old floor was fairly smooth and that the rather rugged topography now existing has been produced almost entirely by stream erosion since the stripping off of the sediments.

There is reason to believe that the surface was not entirely free from small hills or knobs which rose above the general level. In the adjoining Little Falls district Professor Cushing has described a very clear-cut example of such a knob at Diamond hill[1]. Myers

[1] N. Y. State Mus. Bul. 77. p. 57–58.

hill in the north central part of the Remsen quadrangle may possibly represent such an ancient hillock. This hill rises abruptly almost 200 feet above the surrounding country and is separated from a still higher hill to the northeast by a narrow depression. This depression is difficult of explanation on the basis of the existing drainage, but it may be readily accounted for by the action of a Precambric stream.

Slope of the surface upon which the Trenton was being deposited

Not far beyond the map limits to the southeast the Trenton shows an increase in thickness, towards the southwest, of about 100 feet in 5 miles. This indicates that the slope of the surface on which the Trenton was being deposited was about 20 feet per mile southwestward.

The thickness of the Trenton formation (including the Lowville) at Trenton Falls is probably not far from 300 feet. In the Globe Woolen Mills well at Utica it is 510 feet, which is an increase of 210 feet in the distance of 14 miles. Hence the slope of the floor here upon which the limestone was laid down was about 15 feet per mile southward.

In the Rome well the Trenton is 375 feet thick and 20 miles to the northeast it is from 200 to 250 feet or an increased thickness northwestward of from 125 to 175 feet. This indicates that the surface receiving limestone deposition sloped 6 or 8 feet per mile southwestward.

Thus the general facts seem to be that the floor upon which the Trenton was being laid down sloped 6 or 8 feet to 20 feet per mile southwestward and that the slope was less in the northwestern part of the region.

Present Precambric slope beneath the Paleozoics

At Northwood the Precambric lies at an elevation of 1220 feet, while in the Campbell well near Utica it was struck at 1500 feet below sea level. The distance between the points is 21 miles and the difference in Precambric elevation is 2720 feet which shows a present Precambric slope of 130 feet per mile southward.

The Precambric at Forestport lies at 1140 feet and in the Rome well at 1105 feet below sea level, thus showing a difference in elevation of 2245 feet in a distance of 20 miles or a slope southwestward of about 110 feet per mile.

In the same way the difference in elevation between the Precambric at Forestport and at Vernon is found to be 2965 feet.

The distance between the places is 30 miles and hence the slope southwestward is about 100 feet per mile.

Slope of the surface where no Paleozoics now cover

At Forestport the Precambric outcrops at 1140 feet and 6 miles northeastward at 1500 feet. The difference in elevation is 360 feet or the southwestward slope is 60 feet per mile.

At the mouth of Little Black creek the Precambric lies at 1180 feet and 1½ miles north of Reeds Mill it lies at 1900 feet. The distance is 10 miles and the difference in elevation is 720 feet. Hence the Precambric slope is here 72 feet per mile southwestward.

At Northwood the Precambric is exposed at 1220 feet and 10 miles northeastward at 2210 feet, showing a difference in elevation of 990 feet. The slope southwestward is thus nearly 100 feet per mile.

From these considerations it is evident that the general Precambric slope where not now covered by the Paleozoics is much less steep than where covered. This marked difference is readily accounted for by erosion and gives us some idea of the amount of erosion in the Precambric surface since the Paleozoics were removed. The original dip of the Paleozoics was found to be 50 to 100 feet per mile which is considerably less then the slope of the Precambric beneath them. Also the dip of the Paleozoics is very nearly the same as the present slope of the Precambric where no Paleozoics cover.

ABSENCE OF THE DOLGEVILLE (UPPER TRENTON) SHALES

The Dolgeville shales, formerly called the Trenton-Utica passage series, and described by Cushing are always present between the Trenton proper and the Utica shale in the Little Falls district.[1] The rocks of the series are rather thin bedded, alternating limestones and shales and are distinctly transitional in character. A maximum thickness of about 100 feet is shown in the Little Falls district. Over the entire Remsen quadrangle such transitional beds are nowhere exposed, although the Trenton limestone covers a wide area and in a number of places the Utica and Trenton may be seen in close proximity if not in actual contact. A small area in the southeast corner of the quadrangle especially that portion known as Sand hill, is probably occupied by the Dolgeville shales which here represent the northwestward extension of the same

[1] *Op. cit.* p. 31–32. *See also* p. 20 of this report.

formation as mapped upon the Little Falls quadrangle. Sand hill and vicinity are covered by very deep glacial drift so that no rock exposures whatever may be seen to make the mapping certain.

The characteristic absence of the Dolgeville shales over the Remsen district as opposed to their presence over the Little Falls district calls for an explanation. A careful comparison of the sections in the two regions shows that the difference is probably not as great as at first sight appears. The sections are here given for comparison.

Type section in the Trenton Falls district

3 Utica shale 300 + ft	Thin bedded black shales somewhat calcareous at base. (Sharp contact)	
2 Upper Trenton limestone 140 ± ft	*b* Thick bedded, coarse grained, gray crystalline beds, 30 ft. (Fairly sharp contact)	
	a Thin bedded, impure beds with pronounced shale partings. 110 ± ft. (No sharp contact)	
1 Lower Trenton limestone 140 ± ft	Thin bedded, impure limestones with thin shale partings	

Type section in the Little Falls district

3 Utica shale (as above) 600 + ft	(No sharp contact)
2 Dolgeville shales 100 ft	Thin bedded, alternating limestone and shale layers of about equal thickness. (No sharp contact)
1 Trenton limestone 100 ft	Thin bedded impure limestones with thin shale partings

These sections show a rapid thinning of the Trenton southwestward. Even when the Lowville and Dolgeville shales are included with the Trenton proper in the Little Falls district, the thickness is only 200 feet as opposed to nearly 300 feet for the Trenton formation at Trenton Falls. This thinning continues southeastwardly to Canajoharie. Thus a slower rate of subsidence eastward while the limestones were forming was doubtless an important factor in causing the thinning in that direction. But as Cushing has suggested, a change in lithologic character of the

formation across country might well be considered. From the lithologic standpoint the most striking difference comes from a comparison of the upper Trenton on the one hand with the Dolgeville on the other. The removal of the thin mass of coarse crystalline limestone from the Trenton Falls section and an increase in thickness of the shale partings in the rest of the upper Trenton there would result in a formation like that of the Dolgeville shales. Such a change could have been effected by comparatively small differences in conditions of deposition. This argument comes to one with special force while looking at the thick mass of thin bedded limestones with pronounced shale partings just beneath the coarse crystalline limestone at Trenton Falls. The presence of the pure coarse crystalline limestones around Trenton Falls signifies clearer water conditions and the sharp contact with the Utica shales signifies the sudden advent of muddy water, although the sharpness of the contact is somewhat modified by the calcareous character of the lower shale beds. In the vicinity of Little Falls the transition from limestone to shale was more gradual. Thus we see that the upper Trenton of Trenton Falls is in all likelihood to be correlated with the Dolgeville of the Little Falls section; that these correlated portions are lithologically not greatly different; and that comparatively slight changes in the conditions of deposition readily account for the absence of the Dolgeville shales in the Trenton Falls district.

Minor evidences to show local changes in sedimentation in the lower part of the Trenton formation near Little Falls are to be found in the only occasional presence of the Black River beds and the great variations in thickness of the Lowville.

GLACIAL GEOLOGY

In the Trenton Falls district there is abundant evidence to prove the former presence of the Post-tertiary ice sheet. The evidence consists chiefly in the glacial drift such as the till, morainic deposits, and the general sand and gravel deposits which are so widely scattered over the Remsen quadrangle. Sometimes large areas are so thoroughly drift covered that the underlying formations are completely concealed from view. The heaviest accumulation of drift appears to be over a broad area extending from southeast to northwest across the map. In this area scarcely an exposure can be found except here and there along the stream courses where the drift has been worn through.

The full significance of the glacial deposits of the Remsen quadrangle will not be known until careful work has been done in the contiguous areas and in fact along the whole Mohawk valley. The writings of Chamberlin,[1] Brigham [2] and Cushing [3] are here referred to as bearing directly upon the subject. Brigham, whose work is particularly noteworthy, is now engaged in further study of this problem. The discussion here presented is decidedly local in its character, the purpose being merely to record certain observations and to offer some suggestions which bear upon the broader problem.

Ice erosion

As the ice slowly moved across the country the preglacial rock surface was more or less scratched and eroded, but there is no good reason for thinking that the old rock surface was profoundly affected in this way. In the western part of the district, and extending out for a considerable distance from the shale area the heavy crystalline beds of the upper Trenton nearly always make up the surface rock formation and no isolated shale masses can be found. The shale rises rather abruptly above the limestone area culminating in the high land around Starr hill. The writer inclines to the belief that immediately before the advent of the ice, thin shale masses extended farther eastward over the limestone. Certain it is that at one time the shale did thus extend out and that it has been removed either by water erosion or by ice erosion. As the ice moved across the country the tendency would be for the softer shales to be more easily removed than the more resistant heavy beds of limestone. Both types of erosion should be considered and no doubt the stripping off action of the ice was important. Among the evidences favoring this view are: the presence of the thin mass of coarse crystalline limestone over such a wide area; the greater resistance to erosion of the limestone; the prevalence of glacial till full of shale fragments and directly overlying the limestone.

Direction of ice movement

Chamberlin, in the report above referred to, makes the tentative statement " that strong ice currents swept around the Adirondacks and entered the Mohawk valley at either extremity, while a feebler current, at the hight of glaciation probably passed over the Adirondacks and gave to the whole a southerly trend." Observations by later investigators have tended to bear out this view. This con-

[1] U. S. Geol. Sur. 3d An. Rep't., p. 361–65.
[2] Geol. Soc. Am. Bul. 9, p. 183–210.
[3] N. Y. State Mus. Bul. 77, p. 73–81.

clusion is based upon the direction of glacial striations and upon the distribution of glacial deposits and topographic forms.

As regards rock striations the writer has but a single observation to record and that is an unsatisfactory one. The striations occur upon the syenite along Big Woodhull creek, 2 miles northeast of Forestport. They bear approximately s. 30° e.[1] The general northwest-southeast distribution of the moraine deposits [*see* below] agree closely with the reading above given. Also the abundant shale fragments in the till to the north and east of Remsen and Prospect were very largely derived from the shale around Starr hill and this implies a general southeastward movement of the ice. Down the Mohawk valley the striations and topographic forms show an east and west arrangement. Along the northwest border of the Adirondacks, as near Clayton, the writer has seen many striations pointing southwestward. All these facts are clearly in harmony with the idea of Chamberlin above quoted. Since the Trenton Falls district is situated along the southwestern side of the Adirondacks a southeastward movement would be expected such as the records suggest. At the hight of glaciation however this ice current must have given way largely to the more general southward current across the Adirondacks. The distribution of erratics [*see* below] over the Remsen quadrangle as well as for many miles southward confirms this belief.

Glacial till

Glacial till or ground moraine material is exposed at many places throughout the district. Over the Precambric area the exposures are not so common and the material is characteristically light colored, very sandy and full of coarse gravel as may well be seen along the State road west of Reeds Mill. The rock fragments in this till represent various Adirondack rock formations. The best exposures are found along the principal stream courses, as for example in the vicinity of Enos. Over the Paleozoic area the till varies much in character chiefly according to the kind of underlying rock formation. Where the till rests upon the Utica shale it is always dark colored and full of black shale fragments. Where the limestone is the country rock the till is lighter colored and full of limestone (usually coarse crystalline) fragments. Near the shale contact and for some distance away from it the color and composition of the till is generally intermediate, containing both shale

[1] More recently the writer has observed good striae on the syenite near Hawkinsville, just off the map to the northwest. These striae also bear about s. 30° e.

and limestone. Such till is commonly seen between Remsen, Hinckley, Trenton and Steuben valley. The till is nearly always covered with sand or sand and gravel.

The best single exposure of glacial drift, including till at the bottom, is at the sharp creek bend southwest of Hinckley [*see* pl. 9]. The creek is rapidly cutting into the soft drift material and an excellent section over 200 feet thick is exposed. In the bed of the stream here upper Trenton limestone outcrops. Resting directly upon the limestone is a thin bed (1 or 2 feet thick) of stratified sand clay. Above this comes a bed of bluish gray clay (till) full of glaciated limestone boulders, together with some Adirondack rocks. This bed makes up about ¼ of the total hight of the bank. Then comes a mass of sand crudely stratified and cross-bedded, with some gravel streaks and making up approximately ½ the hight of the bank. The upper ¼ of the section is made up of coarse gravel showing crude stratification and cross-bedding.

Till is also well shown at Remsen, east of Prospect and along the streams, near the shale contact, north and northeast of Steuben Valley.

Kame-morainic deposits

A broad belt of kame material extends across the map from southeast to northwest. The width of this belt is generally several miles and although it varies a good deal, and is of uncertain extent, it is nevertheless a distinct feature of the region. Strictly it must be regarded as a lateral moraine, but for most part it partakes of the nature of a terminal moraine. The continuation of this morainic belt southeastward across the Little Falls district has been described by Cushing.[1] It also continues northwestward across the Port Leyden district as is clearly shown upon the newly published topographic map. Presumably this moraine was formed near the edge of the ice sheet during a pause in its retreat as it was melting and retreating southwestward from the Adirondacks. The character and depth of the deposits argue for a nearly stationary condition of the ice for a considerable length of time. Sometimes the deposits show no signs of stratification but at other times a crude stratification is clearly evident, hence the application of the term "kame-moraine." The stratification indicates deposition in connection with water, probably emerging from along the ice edge, and whose currents were shifting. The familiar "knob and kettle" structure of terminal moraine topography is often locally well de-

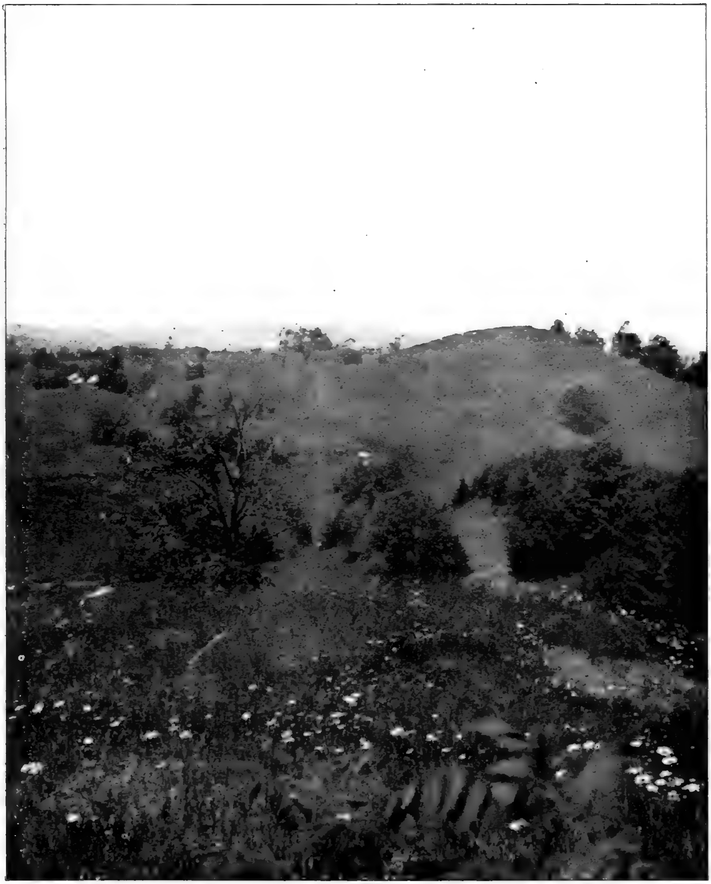
[1] *Op. cit.* p. 75.

Plate 9

W. J. Miller, photo.

Section showing the character of the glacial drift ½ mile southwest of Hinckley, where West Canada creek makes a sharp bend. The thickness of the section is about 200 feet. Heavy beds of the upper Trenton are visible at the water level to the left. The lower 50 feet is bluish gray till containing striated limestone boulders; the middle 100 feet is crudely stratified sand; while the upper 50 feet is cross-bedded gravel.

Plate 10



W. J. Miller, photo.

Kame hills of the "kame moraine" 2½ miles east of Remsen. The view was taken from the top of a kame.

veloped. The greatest accumulation of kame-moraine materials (sand and gravel) is in the vicinity of Hinckley and for 5 or 6 miles northward where it forms a ridge rising from 100 to 200 feet above the surrounding country [*see* pl. 10]. Many kame hills and kettle holes (not shown on the map) occur in this locality.

Sand hill at the extreme southeast is another example of the kame-moraine hills. The deposit here consists of sand and gravel, is crudely stratified, and is several hundred feet deep.

Minor kames occur 1 mile east of Bardwell Mill and 2½ miles northwest of Enos, and 2 and 3 miles northeast of Remsen.

A little over a mile south of Forestport there is a group of kame hills in the midst of which lies a "kettle hole," 30 or 40 feet in depth. Three such hills forming a group, 3 miles northeast of Forestport have a deep "kettle hole" between them.

Stratified clay deposits

Thinly stratified or laminated clays have been noted in a number of locations, and they certainly indicate the former presence of lakes. Such clay beds, lying between the 1200 and 1300 foot levels, occur over the whole area between West Canada and Black creeks and to an unknown distance eastward beyond the map limits. These clays also extend a little north of West Canada creek and for a considerable distance south of Black creek. The best exposures may be found along the creek south of Northwood and along Black creek between Grant and Gray. Sand everywhere rests upon the clay above the 1300 foot level. The evidence is conclusive that an extensive body of water once occupied the area here described. The water, in all likelihood was held in by the ice front or morainic deposits or both on the south side and by the high Precambric land on the north side.

Similar clay beds outcrop extensively along Black river between 1 and 2 miles southwest of Enos and again at the small lakes 2 miles east of Bardwell Mill. Between these points clay beds also appear. The exposures all lie between the 1200 and 1260 foot levels and argue for the existence of a lake of considerable size. This water body and the one above described were at approximately the same level and they may have been joined during part or all of their existence.

Stratified clays may be seen along West Canada creek south of Trenton Falls at a much lower level (740 feet). This water body was formed at a later time when the ice had retreated farther south.

Another lake in the extreme northwest extending to an unknown

distance beyond the map limits existed at an elevation of from 1100 to 1150 feet. The clay beds are best shown along the canal feeder between 2 and 3 miles northwest of Forestport and also along Crystal creek and Cold brook. These and probably other water bodies were doubtless formed behind the ice front or morainic deposits acting as a dam on the west.

Sand deposits

Extensive deposits of sand, frequently associated with gravel, and more or less distinct from the kame-moraine material, occur within the district. These sand areas, which are locally called "sand flats," for the most part lie east of the Precambric Paleozoic boundary line. Many times these sands show no sign of stratification while at other times a crude stratification can be made out.

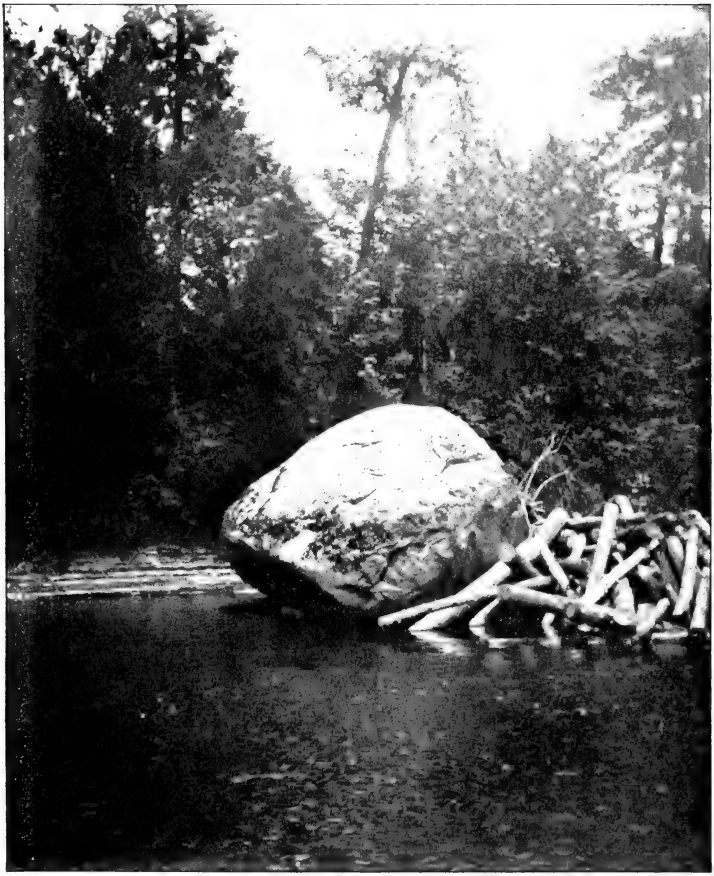
The largest sand covered area lies between Alder Creek, Enos and Myers hill and northwestward beyond the limits of the map. Over this whole region occupying about 50 square miles scarcely any rock exposures can be found except along the principal stream bottoms.

Sand flats are also found to the east, southeast and south of Enos. The most interesting sand flat is the one lying between West Canada and Black creeks. The topographic map shows it as a flat topped bench or terrace. The sand is here from 50 to 100 feet deep and is underlain by the extensive clay beds above described. Sand flats at lower levels also occur in the vicinity of Trenton Falls.

The problem of the classification and origin of these sands is a difficult one. It is evident from their varying character and distribution that no single explanation will account for them all. In a general way at least the writer offers the suggestion that the unstratified sands were largely deposited as simple drift or morainic material, while the cruder stratified portions were partly the result of overwash deposits from the edge of the ice and the moraine, and partly delta deposits formed where the larger streams emerged from the high Precambric land to the northwest.

The distribution of the sand flats, their absence from the Precambric highlands, the steep slopes of the stream beds and the presence of much sandy drift over the Precambric highland, and the ice and moraine barrier to the southwest causing the formation of the lakes and acting as a general obstruction to drainage would altogether strongly argue for the delta method of origin of much of the sand. Thus the sand overlying the clay between West Canada

Plate 11



W. J. Miller, photo.

A glacial boulder or erratic in the bed of Black creek, ½ mile northwest of Grant. The rock is syenite and it rests upon Trenton limestone. Limestone layers show at the left. The logs are 13 feet long.

and Black creeks was most likely pushed out over the clay as a delta deposit by the creeks named. The heavy sands around Trenton Falls are thought to be of later origin as delta deposits from West Canada creek when the ice had retreated farther south

Erratics

The whole region covered by the map is strewn with thousands of glacial boulders or erratics. These erratics are mostly representatives of the Precambric formations, even over the Paleozoic area. They vary in size from those which are very small to others which are 10 or 12 feet across and weigh from 50 to nearly 100 tons apiece. The accompanying photograph [pl. 11] shows a large syenite erratic resting on the Trenton limestone in the bed of Black creek below Grant. Glacial boulders of considerable size are often associated with the kame-moraine deposits as for example north of Hinckley. Over the typical sand flat areas they are generally absent and this is probably due to the deposition of these sands after the retreat of the ice thus causing them to be buried and lost to view except along the stream channels where they have been again exposed by subsequent erosion of the sands. The erratics over the Precambric area cause trouble in mapping because it is often difficult to distinguish between them and true outcrops. In the fields around Remsen and Alder Creek station hundreds of large erratics may be seen.

The distribution of these glacial boulders whose source was in the Adirondacks, over the southwestern portion of the district as for instance over Starr hill and to the west as well as for many miles south of this region indicate that at the hight of glaciation the predominating ice current was southerly rather than southeasterly.

Drainage

For the most part the larger streams such as Black river, West Canada and Black creeks, now occupy the same channels that they did during preglacial times. The most noticeable exception is the course of West Canada creek below Prospect. Between Prospect and Trenton Falls, West Canada creek certainly passes through a postglacial channel as shown by the series of waterfalls and the steep sided gorge. The writer has every reason to agree with Brigham[1] who has discussed the matter and who makes the following tentative statement. " It is held as possible that before glacial

[1] Geol. Soc. Am. Bul. 1898. 9:191.

times its course may have continued to the southwest, past Holland Patent, along Nine Mile Creek valley to the Mohawk, near Oriskany. The evidences are a broad open valley, adequate to the Ohio or Susquehanna, at Holland Patent and Stittville, now occupied by a minor stream; the more normal arrangement of drainage thus postulated; massive barriers of glacial debris north and east of Holland Patent; superior altitude of West Canada creek bottom below Trenton Falls as compared with Holland Patent; a very level stretch of some five miles of the West Canada creek about Poland, and the constriction of the valley about Middleville. The supposition is that morainic obstruction blocked the old channel and sent the creek across a col not far from Middleville."

The course of the preglacial stream between Prospect and Holland Patent is not certainly known but it was probably a short distance south of the fault-fold line judging by the heavy drift deposits and lack of rock exposures there. Above Hinckley, West Canada and Black creeks are in or close to their preglacial channels which have been so thoroughly drift filled that the only rock exposure is at Grant. The small rock channel at Grant probably means that the stream has slightly diverged here.

Black river above Enos is certainly in its old channel while at Enos and for several miles down the stream appears to have abandoned its old course. The rock gorge at Enos is certainly of recent origin. The lower course of the stream upon the map seems to follow the preglacial channel except possibly at Forestport where there may have been a slight divergence. Where the railroad crosses Big Woodhull creek the stream is out of its old course as shown by the steep sided rock channel. Town Line (Cincinnati) creek must occupy a postglacial channel between Remsen and near its mouth, as is particularly well shown by several waterfalls and the small gorge northeast of Trenton village.

ECONOMIC GEOLOGY

Soils

The best soils are found over the Paleozoic rock area, the richest farming section covering the western portions of the towns of Remsen and Trenton and the eastern portion of Steuben. Over the section named the drift is generally shallow and the shale and limestone soils make rich farming lands.

The whole region of the kame-moraines and sand flats is characteristically barren, the soil generally consisting of almost pure loose sand which does not afford proper nourishment for plant life unless

well fertilized. In every case, over this region however, where the clay beds are at or near the surface more fertile spots are to be found. The potato crop seems to be best adapted to these sandy soils. In the region to the north and east of Forestport and of Grant many deserted farms may be seen. Formerly the people who lived in these districts were mostly engaged in the timber business, but since the removal of the timber the soils alone have often been too poor to support the families.

The northwestern Precambric highlands are not so heavily drift covered; deep soils are scarce; and the region is mostly wooded. Where occasional patches of soil can be found they are generally fairly productive.

Building stone

The coarse crystalline limestones of the uppermost Trenton afford the best building stone in the district. This rock occurs in thick beds separated by thin shale partings and hence is easy to quarry. A number of large quarries have been opened along West Canada creek between Prospect and the railroad bridge. Quarries near Prospect are now in operation for the production of building stone. This limestone has also been burnt for lime. The same rock has been quarried along the fold-fault line between Trenton and Holland Patent; north of Steuben Valley and along the creek south of Remsen. The extent of the limestone as a surface rock is given above.

The Lowville limestone outcropping along Black river at the extreme northwest is not worked but it would make an excellent building stone.

Because of the expense involved in quarrying and cutting the Precambric rocks have been very little used for building purposes. The railroad company has quarried the stone at Meekerville and at the point where the railroad crosses Big Woodhull creek, for local use in the bridge abutments.

Road material

An unlimited supply of excellent road material is to be found over the whole Precambric area. Most of these rocks would be very suitable although the pure syenite because of its hardness and resistance to wear is best. The expense in quarrying and the general lack of interest in good roads has prevented its usage to any extent.

A rock which is more easily available and better adapted to the usual kind of road work is the coarse limestone at the top of the

Trenton. This rock is much softer than the syenite although it withstands a reasonable amount of wear. The middle and lower Trenton limestones afford road material of medium quality.

Sand and gravel

Sand and gravel of good quality occur in practically unlimited quantities, especially over the moraine and sand flat belt. The railroad company has removed large quantities from a number of places along their lines. Much sand is being shipped by canal from northwest of Forestport to Syracuse and other interior points to be used for building purposes.

Clay

The clay underlying the sand flat between West Canada and Black creeks is of excellent quality and almost unlimited in quantity. It is very fine grained, free from grit or gravel and would be well suited for the manufacturing of brick, tile etc. The clay beds farther northwest are of similar quality.

Iron ore

In the Precambric area some prospecting for iron ore has been done in at least two localities. One of these is situated about ½ mile south of Ash ridge and on the divide between Hare brook and Big brook while a second place is about ¾ mile north of Enos. The prospects are small pits made largely by blasting. The ore is magnetite which occurs in a coarse grained rock, and associated with feldspar, ranging from oligoclase to labradorite, and a considerable percentage of quartz. The ore-bearing rock is usually associated with a dark gray banded rock in which the dark bands are very biotitic. The best specimens found by the writer did not contain more than 20% of magnetite. Many years ago some ore was shipped out but the quality was found to be too poor. There is nothing to indicate that further prospecting at the places mentioned would bring to light any good ore. Magnetite is a very common constituent of the syenite rocks and at times it appears to be particularly rich in what the writer regards as segregation masses. Small patches of magnetite have been often observed especially in the more syenitic rocks of those mapped as Syenite-Grenville. It should be noted that the Salisbury iron mine a number of miles to the southeast as well as the prospects here described all occur within the Syenite-Grenville areas. Possibly the close association of the syenite and Grenville in some way made the conditions for segregation more favorable.

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Education Department Bulletin

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No. 442 ALBANY, N. Y. MARCH 1, 1909

New York State Museum

JOHN M. CLARKE, Director

Museum bulletin 127

GLACIAL WATERS IN CENTRAL NEW YORK

BY

H. L. FAIRCHILD

PAGE

New York State Education Department
Science Division, November 19, 1907

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I communicate herewith for publication as a bulletin of the State Museum a paper prepared at my request by Prof. H. L. Fairchild on the *Glacial Waters in Central New York.*

Very respectfully yours
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 20th day of November 1907

Commissioner of Education

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GLACIAL WATERS IN CENTRAL NEW YORK

BY

H. L. FAIRCHILD

INTRODUCTION

Scope of the paper. Several of the earlier papers by the writer described the glacial lakes or standing waters held in central New York by the waning glacier [*see* the bibliographic list, p. 59, titles 16, 25, 26]. Later writings have for their subject the glacial drainage channels and the ice-impounded waters east of Syracuse [titles 27, 28, 31] and west of Batavia [title 37]. The present writing describes the ice border drainage in central New York and discusses the relation of this stream flow to the standing waters of the region and to both the eastern and western escape.

While the drainage features of the district are conspicuous and their origin by the work of glacial rivers is perfectly evident yet their sequence in time and their relations to the lake waters are not clear without careful study of the entire region. The glacial lake history in central New York is somewhat more complicated than has been supposed, and the drainage phenomena are involved in the problems.

Maps. The key map, plate 1, shows the channels in a generalized way from the neighborhood of Batavia east to Utica and Little Falls, thus covering all the territory on the east described in former writings. The key map published in the State Museum bulletin

[title 37] shows the west-leading channels west of the Batavia district. These two general maps depict all the glacial stream channels in central-western New York except those leading to southern drainage and the higher cross-ridge channels.

The detailed maps, plates 2–5, utilize as a base the sheets of the New York State topographic map. The series herewith given forms a complete map of the belt along the 43d parallel between Leroy and Oneida, a distance of over 125 miles, with the exception of the Weedsport quadrangle, on which no channels have been located.

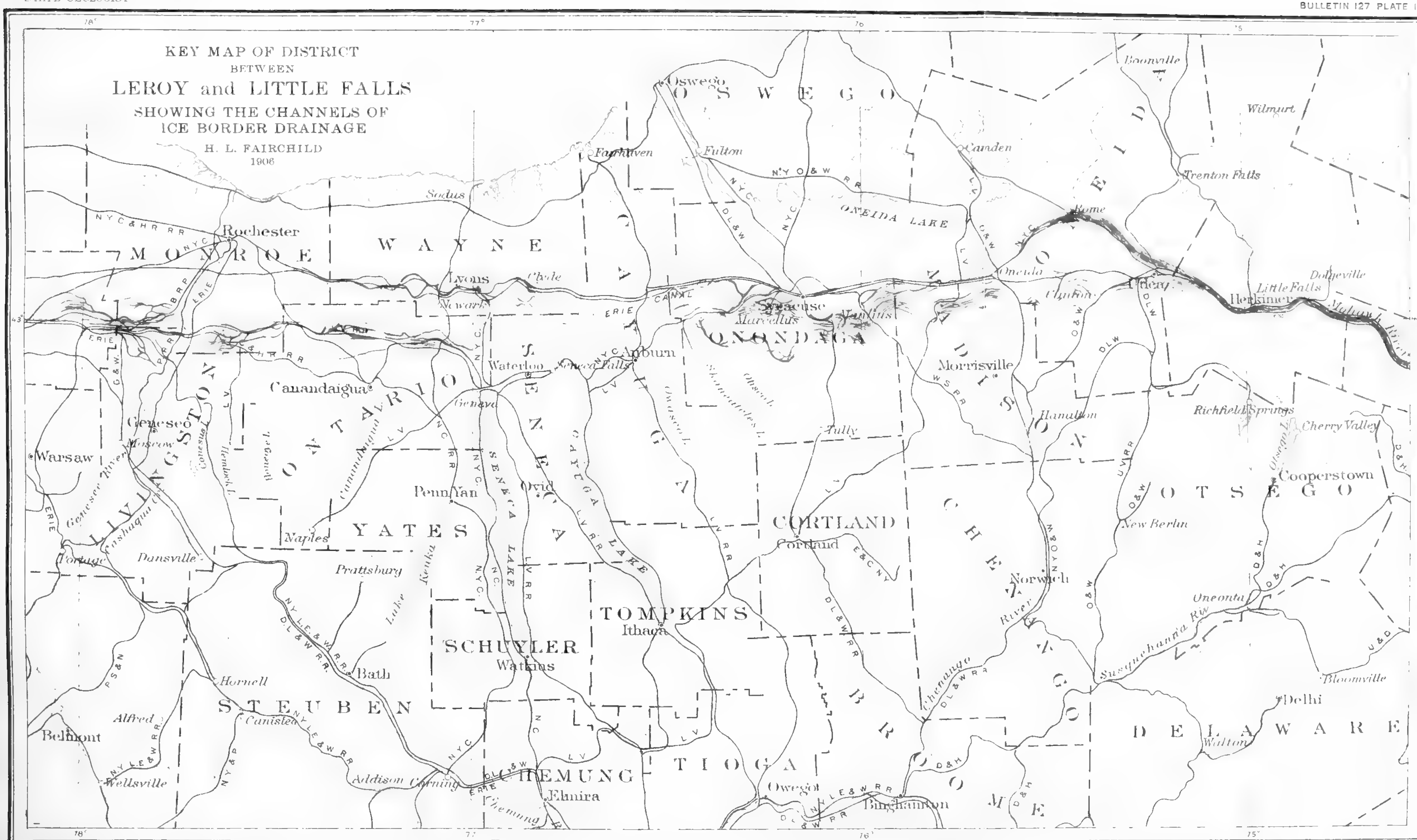
Beyond the territory of plate 5 the glacial stream channels have already been depicted in the same style or convention employed in the accompanying maps. The maps included in former publications [titles 28, 31, 37], in conjunction with the maps here in hand show with some detail all the later ice border drainage from the extreme west end of the State, at State Line, eastward to Little Falls in the Mohawk valley.

Acknowledgments. For courtesies and assistance in the study of the glacial geology of central New York the writer is under pleasant obligations to many persons, and special thanks are due the following: Dr C. E. Fairman, Lyndonville; Mr J. W. Holmes, Batavia; Mr W. S. Hosmer, Clifton; Mr E. P. Clapp, North Rush; Mr J. P. Slocum, Albany, formerly of Nunda; Mr Shelley G. Crump, Pittsford; Mr D. D. Luther, Naples; Mr N. L. Ogden, Penn Yan; Dr M. A. Veeder, Lyons; Mr Philip F. Schneider, Syracuse; Dr S. Ellis Crane, Onondaga Valley and Prof. George H. Chadwick, Canton.

Dr G. K. Gilbert was the first to recognize the significance of the drainage features, and to him the writer is especially indebted.

Terminology. A few words require frequent repetition in this writing. To save a reiteration of the term " channel " as applied to the excavated path of a stream, the term " scourway " will sometimes be used to name the shallow and less definite channels. " Gorge " and " canyon " will sometimes be applied to deep, narrow channels, specially if they have rock walls. The common terms cut, notch and terrace will sometimes be used where appropriate.

The terms " ice border " and " proglacial," applied to the drainage along the edge or front of the ice sheet, are used as equivalents.


KEY MAP OF DISTRICT
BETWEEN
LEROY and LITTLE FALLS
SHOWING THE CHANNELS OF
ICE BORDER DRAINAGE
H. L. FAIRCHILD
1906
MONROE
WAYNE
OSWEGO
ONEIDA
ONONDAGA
MADISON
ONTARIO
SENECA
CAYUGA
LIVINGSTON
YATES
CORTLAND
CHENANGO
OTSEGO
TOMPKINS
SCHUYLER
STEUBEN
CHEMUNG
TIOGA
BROOME
DELAWARE
Oswego
Fulton
Fairhaven
Sodus
Rochester
Lyons
Clyde
Newark
Camden
Boonville
Wilmurt
Trenton Falls
Rome
Oneida
Utica
Clinton
Herkimer
Little Falls
Dolgeville
Mohawk River
Syracuse
Marcellus
Manlius
Auburn
Seneca Falls
Waterloo
Geneva
Canandaigua
Geneseo
Moscow
Warsaw
Portage
Dansville
Naples
Penn Yan
Ovid
Prattsburg
Morrisville
Hamilton
Richfield Springs
Cherry Valley
Cooperstown
New Berlin
Tully
Cortland
Norwich
Oneonta
Ithaca
Watkins
Bath
Hornell
Alfred
Canisteo
Belmont
Wellsville
Addison
Corning
Elmira
Owego
Binghamton
Delhi
Walton
Bloomville
Oneida Lake
Cayuga Lake
Seneca Lake
Keuka Lake
Susquehanna River
Chenango River
Genesee River
Erie Canal

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GENERAL DESCRIPTION: PRELIMINARY OUTLINE

The glacier acting as a barrier to northward drainage is the fundamental fact to be apprehended by the reader. The ice sheet was a melting dam during both its advance and its retreat, and waters were flowing copiously from it, not into it. Valleys or land depressions sloping toward the ice front were by the ice barrier made into lake basins [*see* pl. 34–42].

The earliest outlets for the ice-dammed waters were at the heads of the greater valleys, or across the cols, to southern drainage. A later escape of the waters was by flow past the ice margin across the ridges between the lakes, thus draining higher valley lakes into lower lakes. These cross-ridge outlets were successively lowered and shifted northward as the ice front receded, until at lower levels the proglacial drainage formed extended rivers on the intervalley stretches. Rivers of glacial water had no less power of carving channels and building deltas than other streams, and these effects of the ancient rivers are still conspicuous evidence of their existence.

West of Batavia all the glacial waters escaped westward to the lakes held in the Erie basin [*see* title 37, p. 10] and ultimately to the Mississippi river. The same is true of all the waters held in the Genesee region under about 1200 feet (the lowest southward escape of Genesee waters; *see* title 40). This is probably true, also, of all the glacial waters of central New York between the Newberry plane (about 1000 feet on the Batavia parallel) and 900 feet, the elevation of the lowest west-leading channels at Batavia. All the drainage under 900 feet was eastward past Syracuse to the Mohawk valley. These east-leading channels, from their heading near Leroy to beyond Syracuse, form the subject of the present writing.

The general history may be clearer if the physiography of the region is emphasized. In the territory between the meridians of Batavia and Syracuse, covered by the accompanying maps and plates 1–5, at least 13 distinct valleys lie sloping northward. Named in order from west to east these are Oatka, Genesee, Conesus, Honeoye, Bristol (Mud creek), Canandaigua, Flint, Seneca, Cayuga, Owasco, Skaneateles, Otisco and Onondaga. The higher and more local glacial waters in these valleys had different outflow seeking southward escape, but a later stage saw the waters of the broad area collected mainly into two large lakes. One of these was Lake New-

berry which occupied the large, low, central valleys of Seneca, Cayuga and Keuka, with its outlet south through the village of Horseheads to the Chemung-Susquehanna, at a present altitude of 900 feet [*see* titles 16, 26]. The other was the Genesee valley waters which escaped at different times and levels to Susquehanna, Allegany-Ohio-Mississippi and Erian-Mississippi drainage [*see* title 40].

The latest stage of the waters, previous to the initiation of the channels to be described, seems to have been the union of these two bodies of water into one extensive lake, outflowing westward by the lowest channels southwest of Batavia, above 900 feet, into Lake Warren. Whether Lake Newberry found any escape eastward, in the vicinity of Syracuse, before its lowering waters became confluent with the Genesee waters is not certain, but this seems unlikely. This wide extended central New York water probably extended from Batavia eastward nearly to Syracuse; bounded on the north by the ice front, and with many southward prolongations extending up the valleys. It is the same water as noted above lying in altitude between the Newberry plane and 900 feet, and is an important lake in relation to the drainage history of the region. It is the lowest stage of the waters formerly called the Warren Tributary lake, the seventh stage of the Genesee glacial waters as described in a former writing [title 21]. These waters were falling in altitude, indefinite in boundaries and comparatively transitory in life, on which account they might not deserve a distinctive name; but being an important link in the chain of lake succession, and requiring frequent mention, it is desirable to give them a name, and we have called them Lake Hall, after James Hall, whose classical report [title 5] covered the outlet district [*see* title 40 and pl. 36].

While the ice-fronting waters were standing at the Batavia level it appears that the waning of the ice barrier in the Split Rock district, west of Syracuse, opened outlets for the water lower than the Batavia escape and the flow was diverted to the east. The continued eastward flow at falling levels produced the stream phenomena which form one special subject of this writing. The facts of observation on which the above history is based will be given below in the descriptive matter. As a distinctive name we have called these standing waters with falling levels and eastward escape Lake Vanuxem, after Lardner Vanuxem, whose territory in the first New York survey [title 4] included the Syracuse region [*see* pl. 37].

One important change in the conception of the glacial lake his-

tory must be noted here. In former writings it was supposed that immediately subsequent to the Batavia outflow the Warren waters invaded the region, from the west, and that the falling Warren, or hypo-Warren waters carved the channels under discussion. In this view the Leroy-Syracuse channels were the latest or closing phenomena of the glacial waters in the region. On the contrary it now appears, with the larger range of facts available, that these channels antedated the Warren waters. The Warren planes, 880 feet, and Dana (hypo-Warren) phenomena, 700 feet, are found far northward of the channels [*see* pl. 2, 3]. The channels were certainly formed at the receding ice border Equally certain it is that the Warren phenomena north of Victor and Fishers, and the Dana cliffs and spits near Bergen and Elba have never been touched by an ice sheet. The only possible conclusion seems to be that the Warren invasion occurred after the low channels were cut at Leroy, Rush, Victor, Clifton Springs, Phelps and the Split Rock district. The very pronounced channel farther north, extending from Fairport to Lyons and eastward, and correlating with the low passages at Weedsport, Jordan, Memphis and Syracuse may have been post-Warren.

The present conception of the lake history negatives the idea of a steady, continuous, single recession of the ice front in central-western New York and requires instead some oscillation of the ice front and a seesawing as between the meridians of Batavia and Syracuse. The low channels through the city of Syracuse must have been open in order to allow the river flow through Victor-Phelps at 500 feet; and the Warren waters were then excluded by the ice barrier lying against the high ground north of Batavia. On the other hand the existence of Lake Warren in central New York, the proofs of which are positive, requires a recession of the ice north of Batavia and the readvance and blocking of the Syracuse channels up to at least 890 feet.

On the Split Rock meridian there is a singular complication of the channel phenomena, described on page 23, which also requires oscillation of the ice barrier on that line.

To return to the general description of the channel features: On any meridian the channels lie in series, falling northward, as required on the theory of a receding barrier. This feature may be clearly seen on the meridians of Mumford and Rush, plate 2; Shortsville and Clifton Springs, plate 3; and very strikingly at Split Rock and Jamesville, plate 4. This fact is sufficient proof that these

channels were carved directly at the ice edge, or in other words that the streams here laved the ice front. On the other hand the Fairport-Lyons channel although initiated at the ice front continued to remain effective long after the ice had left that parallel, for the reason that higher ground lies on the north.

The higher (southward) and more interrupted channels lie on the steeper part of the north-facing slope, formed by the scarp of the Onondaga limestone, and are frequently only benches in the slope. That is to say, only the south banks of the channels are in existence, as the north bank was the glacier ice. The lower and more continuous channels are in the soft Salina shales; those at Mumford, Scottsville, Rush and Mendon [pl. 2] and Victor [pl. 3] being in the upper and harder shales, while the channels east of the Cayuga meridian are in the very soft and erodible lower (Vernon) shales.

The maps will show that the stream flow was interrupted by north and south depressions, and it will be understood that these surfaces below the channels must have been occupied by standing waters or lakes. Into these lakes the inflowing streams carried their burdens of detritus and built deltas in the western margins of the lakes. A necessity for the continuous flow was a sequence of declining channels to the eastward.

Two pronounced depressions lie athwart the general course of the stream flow. One is the Genesee valley, some 3 to 4 miles wide, in the waters of which the rivers from the west built broad deltas, extending north from Fowlerville to Scottsville. The other depression is the Cayuga basin, the broad tract of the Montezuma marshes. Over this stretch of about 25 miles, or between the meridians of Geneva and Jordan the waters seem to have formed an extensive but shallow lake.

The eastern channels, in the Syracuse district and eastward, are more broken by deep, narrow valleys. The plateau of southern New York, trenched by preglacial stream valleys, reaches to the Syracuse parallel where it drops off abruptly. At different times and for many centuries the glacier front rested against the steep north edge of the plateau all the way from the Skaneateles meridian east to Utica, and the escaping waters were forced to cut deep trenches or notches in the north ends of the intervalley ridges. The valleys in which waters were ponded with changing levels are: Skaneateles, Otisco (Marcellus), Onondaga, Butternut and Limestone, and several valleys farther east; all of which have been described, in this relation, in former papers [*see* titles 25, 26, 28, 31].

Plate 6

CHANNEL OF ICE-BORDER DRAINAGE

"The Gulf," 3 miles west of Mumford. View looking northeast (downstream)

The chronologic order of the glacial stream flow seems to have been as follows, at least in its general sequence. The eastern channels were opened successively to the westward, that is from Little Falls and Utica westward to Syracuse, thus permitting eastward flow to the Mohawk valley. During the same time the waters in the Erie basin were invading eastward thus allowing westward flow toward the Mississippi [*see* titles 31, 37]. The waning of the ice front on the west finally permitted westward flow at Batavia as low as 900 feet (Lake Hall), while the ice barrier at Syracuse was yet higher. Later the ice front at Syracuse gave way and all the waters lying east of Batavia and under 900 feet (Lake Vanuxem) were drained eastward to the Mohawk, and the channels emphasized in this writing were then cut. Subsequently a readvance of the glacier in the vicinity of Syracuse and a recession north of Batavia let the Erian waters (Lake Warren) into central New York. Finally another and last recession of the ice at Syracuse permitted low eastward flow and the Warren and hypo-Warren waters were lowered to Lake Iroquois.

The above is only an outline of the main events in the history and is probably inadequate. At least this sequence of ice recession and readvance seem requisite in order to explain the facts as known at present, but it is possible that the oscillations of the ice front in New York were greater in number and the whole history more complicated than is here outlined, and that important events occurred which are not yet even suspected. Some of the puzzling features which suggest complications will be noted later, specially in description of the phenomena in the Split Rock and Syracuse districts.

DETAILED DESCRIPTION

Batavia to Genesee valley

The earliest and highest of this series of ice border drainage channels heads northeast of Leroy on the Onondaga (Corniferous) limestone, at 800 feet altitude. The map, plate 2, shows the stronger or more definite scourways. The later and lower channels head in faint scourways 4 to 6 miles northwest of Leroy, beginning in drift but soon cutting down through the thin edge of the limestone into the underlying Salina shales [pl. 6].

The higher channels east of Leroy swing southeast, up the Genesee valley, while the later channels keep an eastward course. This change in direction of the channels indicates that a lobation

of the ice front rested in the Genesee depression east of Leroy when the earliest ice border drainage occurred, but that the lobation had disappeared when the later channels, leading east toward Scottsville, were made.

All these glacial channels end in the Genesee valley at about 600 feet altitude where they built a series of broad deltas, extending from Fowlerville north to Scottsville through a distance of 12 miles [pl. 7–9]. The control of the water level in the valley was exercised by the channels which carried the lake waters out of the valley and which will be described in the next chapter.

Four lines of railway traverse the channel district from east to west, taking advantage of the level stretches on the limestone prepared by the ancient rivers. All these features are fairly shown on the map, but a few special features require verbal description.

The morainal or marginal drift of the ice sheet is too scanty to represent on the map. There are two reasons for this; first, that the rock rubbish carried by the ice was largely gathered into the drumlin masses, as shown in the upper part of the map, plate 2; second, that the vigorous river work at the retreating ice margin swept the morainal drift eastward into the deltas. Over extensive areas the limestone is practically bare.

The axial directions of the drumlins should be noted. The drumlins south of the parallel of Scottsville have a general north and south attitude, or even northwest by southeast in the vicinity of Linwood, in conformation to the valley slope, produced by the southward flow of the ice lobe in the valley; while the northern drumlins have a northeast by southwest direction, the prevailing direction of all the ice-molded drift on the Ontario plain west of the Genesee valley.

The most singular feature of the district relates to the limestone rock. It will be noted that on the map in the belt traversed by the three east and west railways the channels are not definitely bounded or limited. This is not from lack of knowledge of the district nor because the channels are doubtful. There is no lack of evidence of vigorous stream work, for all the drift has been removed and the limestone eroded. But the rock strata has been so disturbed and the surfaces tilted since the rivers did their work that the continuity of the channels and their walls is largely obscured. The surface of the limestone is thrown into a large number of low but conspicuous ridges and shallow basins due to settling or sinking of the strata. These features were noted in 1891 by G. K. Gilbert and

Plate 7

DELTA OF ICE-BORDER DRAINAGE

West side of Genesee valley, near Canawaugus, 2 miles west of Avon. General view of excavation by the Erie Railroad. Looking east. Compare plates 8 and 9

Plate 8

DELTA OF ICE-BORDER DRAINAGE

West side of Genesee valley. Canawaugus, 2 miles west of Avon. Looking north at front of delta shown in plates 7 and 9

Plate 9

DELTA OF ICE-BORDER DRAINAGE

West side of Genesee valley, near Canawaugus, 2 miles west of Avon. Part of Erie Railroad excavation shown in plates 7 and 8

attributed to the sinkage of the superficial strata by the removal of the underlying salt and gypsum beds through solution [*see* title 8]. South of this parallel, in the Genesee and Oatka valleys are the mines of rock salt and the factories using the brine.

All the ground between Mumford, Caledonia and Leroy is much broken by sinks and sink ridges, of varied dimensions. The ridges vary from doubtful irregularities of the surface up to sharp, broken anticlines sometimes 10 or even 15 feet in hight [*see* pl. 10]. Some of the ridges are short and irregular, many long and winding. Perhaps the more extended are east and west in trend, or along the strike of the rock. The higher and steeper ridges in places resemble scarps due to differential weathering, and some even resemble in form wave-cut cliffs or stream banks. On first inspection the forms would be liable to varied misinterpretations.

These sinkage structures are not only postglacial but subsequent also to the glacial drainage, as they have broken up and obscured the channels. It is suggested that the removal of the soil cover by the glacier, along with some of the superficial, weathered rock, and the subsequent removal of the glacial drift by the ice border rivers exposed the fissures in the strata. The rivers and the subsequent lakes (Warren and Dana) supplied a large volume of water during many centuries for the subterranean circulation and probable removal of a portion of the lower limestone beds and the underlying gypsum.[1] Conspicuous ridges lie along the north side of the highway midway between Caledonia and Leroy for a stretch of 2

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1 Bearing on the origin of the sinkage features the following may be noted.

The surface rocks of the area are Onondaga limestone, beneath which occur in descending order Cobleskill limestone; Bertie waterlime; Camillus (gypsiferous) shales. The gypsum beds lie less than 100 feet below the surface, and are partly above the present surface drainage on the north. Below the base of the Onondaga the depth of the salt is 440 feet at Leroy and 486 feet at Caledonia. The thickness of the salt beneath Leroy is given as 15 feet; and it lies 253 feet above sea level. At Caledonia the highest salt bed is at or below sea level, and south of the parallel the beds are considerably below sea level, due to the southward dip of the strata. Considering that the salt is not only below the level of free circulation but covered by hundreds of feet of quite undisturbed shales the chance for rapid removal seems small. On the other hand the gypsum and the limestones are exposed to subsurface waters with clear drainage. It is important to note that both here and at Syracuse the sinkage has been observed only in the belt along the summit of the Onondaga escarpment.

The parallel of Caledonia and Leroy is the northern edge of the salt-bearing area, the sinkage structures extending a mile or two north of the line. South of the parallel the salt beds increase in thickness, along with the increasing depth below sea level. It has been thought that the present northward limitation of the salt was the original limit of the deposits, but the possible removal of some portion of the northern edge of the beds should be considered.

A point worthy of consideration is the possible amount and the form of the surface dislocation that would be produced by the slow removal of even some scores of feet of salt beneath more than 400 feet of rock, mostly shales. The writer concludes that the irregularity and the sharp relief of the sinkage features indicates the subsidence of only a moderate thickness of rock — perhaps 100 feet.

or 3 miles and are visible from the three railroads. All the ground north of the railroads from Caledonia and Mumford to Leroy has been stream-eroded but the scourways can not be definitely mapped. Similar sinkage features occur on the limestone escarpment west of Syracuse [*see* p. 24].

The altitudes of the channels, always declining eastward, and always successively lower in northward sequence, are sufficiently shown by the topographic contours and numerals of the map. The higher channels, those east of Leroy, carried the overflow of the Oatka valley in addition to the supply from the melting ice, from all the stretch of the glacier front east of Batavia. The lower channels, heading in indefinite scourways northwest of Batavia do not suggest any overflow of the Erian waters eastward past the salience north of Batavia, but seem to have carried only the local waters of the melting glacier and the shallowing lake.

Genesee valley to Irondequoit valley

The glacial drainage described in the preceding chapter built extensive deltas on the west slope of the Genesee valley. This implies lake waters in the valley with correlating outlets on the east. The deltas have altitudes ranging from about 620 feet down to 580 feet, and at precisely these elevations we find capacious channels leading eastward. These are so clearly shown on the map, plate 2, that little verbal description is necessary.

It will be seen that the lowest channel, in which lie the villages of Rush, Rochester Junction and Mendon, is followed by the Lehigh Valley Railroad, and that the Batavia-Canandaigua branch of the New York Central Railroad utilizes for short distances two of the higher channels. The highest cuttings, from 700 feet down, lie west of Honeoye Falls [pl. 11] and are mostly cut terraces or shallow scourways in the Onondaga limestone. The irregular surfaces of the bare rock would not at first sight be confidently attributed to river work, but comparison and correlation study over the district gives certainty.

Southwest of Honeoye Falls, $2\frac{1}{4}$ miles, is a low cataract and plunge basin, known locally as "Dry Pond," produced in the course of the highest channel on the map, at about 680 feet [pl. 12].

Like all the lower channels the Rush-Mendon channel is cut in Salina shale. The highest continuous channel passes a mile north of Honeoye Falls with an altitude of 620 feet. Bending to the northeast it continues around the north side of the Victor kame area,

Plate 10

SINK RIDGE

Broken limestone in anticlinal form produced by subsidence of the adjacent areas. 2 miles west of Caledonia

Plate 11

WORK OF ICE-BORDER DRAINAGE

Bare Onondaga limestone, "Stull farm," 3 miles west of Honeoye Falls. Looking northwest. Compare plates 18, 29 and 30

Plate 12

CATARACT BASIN IN GLACIAL STREAM CHANNEL

"Dry Pond," 2 miles southwest of Honeoye Falls. Looking westward (upstream)

partly as a cut bank, until it blends with the broad Victor channel, described in the next chapter. The lower channel, Rush-Mendon [pl. 13] terminates near Mendon village in a delta, somewhat eroded by recent stream work, lying between Mendon and Fishers, with an altitude of 600 to 580 feet. This delta lies at the present head of the Irondequoit valley, and the glacial waters, which we may call the Fishers lake, had eastward escape through the Victor channel.

One puzzling feature in this district is a coarse, cobbly gravel deposit 1½ miles northwest of Honeoye Falls and east of Sibleyville corners. The Hemlock branch of the Lehigh Valley Railroad has extensively excavated the deposit and revealed a delta structure indicating river flow toward the north or northeast [*see* pl. 14]. This direction is consonant with the preserved glacial channels, but in other respects the deposit does not clearly correlate with the supposed river flow. Modern drainage, specially Honeoye creek, has considerably changed the topography as it was left by the glacial streams, and it is possible that the delta represents an early and higher stream flow at that point. Perhaps it represents work of an earlier ice border drainage during the invasion by the glacier.

Irondequoit valley to the Cayuga depression

Higher series: Victor to Phelps

The glacial drainage across this stretch of 23 miles [*see* pl. 3] although somewhat broken and varied must be studied as a unit. To the continuity of the lower channels there is only one decided interruption, the break at Manchester.

The Lehigh Valley Railroad follows this drainage tract through its whole extent, and the Auburn branch of the New York Central Railroad also, except between Victor and Shortsville.

The highest channel that has been located in this series is quite separated from the others. Plate 3 shows it lying south of Paddleford station and passing east of north to the narrow and poorly defined valley of the Canandaigua outlet, which it intersects less than a mile south of Shortsville. This small but definite channel declines from 740 down to 620 feet. East of the modern Canandaigua outlet and southeast and east of Shortsville there are several scourways and stream banks, from near 700 feet down to 620 feet, which carried the eastward escape of the Canandaigua valley waters, the flow passing immediately south of Clifton Springs.

All the northern edge of the Onondaga limestone in the stretch

of 9 miles between Shortsville and Phelps was swept by the ice border streams. The channeling effects of these higher streams are not so pronounced as in other localities where the flow of water was greater in volume, of longer duration or of steeper gradient, and the limitations of the several stream levels are not all definitely mapped.

The lower channels are well marked and quite continuous. On the meridian of Victor a single capacious channel, lying between highlands both north and south, carried all the glacial drainage represented by the several channels on the east. The Victor channel heads 1½ miles southeast of Fishers with a present altitude of the channel bottom of 580 feet. The earliest stream flow in this notch must have been at some higher level, since the delta dropped by these waters northwest of Manchester, 10 miles east, is 580–560 feet. Leading east from Manchester the main channel starts 580 feet and declines to only 570 in the 7 miles to Phelps Junction. It will be seen that the fall of the streams between the Irondequoit and the Seneca valleys was very small, in consequence of which the flow must have been sluggish and the corrasional power weak. Confirmation of this is found in the shallow, flat and indefinite limitations of the channels, and in the relatively fine material composing the terminal delta.

Between Manchester and Phelps the present outlet of Canandaigua lake follows the lowest glacial channel, and it is not easy to assign the respective effects of the ancient and the modern stream work. The flow through the Victor channel continued long after the ice had left that parallel, and the latest flow probably swung northward through the swampy region of Brownville and Farmington.

All the Victor-Phelps drainage ends in a delta lying on the west side of the Seneca valley and reaching northwest from Geneva for 6 miles or to within about 1 mile of Phelps. The delta is about 1½ to 2 miles wide and declines in altitude from 600 down to 460 feet. Having a steep eastward slope it has been deeply carved by storm wash so that its delta genesis is not evident on casual inspection. Some parts of it resemble a kame moraine in form; and some moraine drift may be included in the deposit. Much of the finest detritus seems to have been borne out into the lake and spread over the low ground towards Waterloo. However, the sandy knolls which now appear over the district, and noticeable along the electric railroad, are dunes.

Plate 13

GLACIAL STREAM CHANNEL

Rush-Mendon channel, $\frac{1}{2}$ mile east of Rochester Junction. Looking east (downstream)

At present it is not possible to correlate the Phelps-Geneva delta and its receiving lake with any particular outlet for the water on the east. The escape must have been 40 miles away, and probably was by the channels between Camillus and Syracuse. Possibly the channels at Elbridge and Hartlot [pl. 4] on the Skaneateles meridian, carried the primary overflow for a time. The close correlation depends on the tracing of the moraines, now very fragmental because eroded by the waters.

Most of the channels of this series are on the Onondaga limestone, which accounts partly for their shallowness, great breadth and indefiniteness of the borders; but the lowest channels in the Phelps district are down in the Camillus or gypsum group of the Salina shale.

Lower series: Fairport to Lyons

Approximately parallel with the Victor-Phelps series of channels is another water course, 6 miles north, of greater simplicity and unity. This heads at Fairport at the present altitude of 460 feet and debouches southwest of Lyons, 26 miles away in a direct line, at 400 feet elevation. The thriving towns of Fairport, Macedon, Palmyra, Port Gibson, Newark and Lyons lie in its course. The New York Central and the West Shore Railroads follow this ancient river course its whole length, as does also the Erie canal. In this connection it should be noted that the glacial waterways through western-central New York have provided the transportation lines with their remarkably uniform east and west grades.

East of Palmyra the channel splits into two, reuniting a mile farther east; but it immediately divides again and surrounds a tract of country about 3 miles in diameter, reuniting 2 miles northwest of Newark. The West Shore Railroad and the Erie canal follow the southern loop and the New York Central the northern loop.

This channel lies in the midst of the dominant drumlin area of central New York [*see* title 39] and these most remarkable and interesting forms of glacial drift border the channel on either hand. East of Palmyra the drumlins themselves do not seem to have been eroded by the stream flow, but instead the channel is somewhat below the base of the drumlins, forming a trench in the soft Salina shales. West of Palmyra some of the drumlins lie at the channel level and have been cut by the widening of the channel.

The map, plate 3, shows open channellike passages north of Newark and Lyons which are not represented as glacial drainage courses, for the reason that at some points they are so constricted

or closed by moraine or drumlin drift that they could not have carried a large volume of water, yet may be as low as the passes which are marked as glacial channels. An example is seen northeast of Newark. The Ganargua creek deserts the channel with direct or easterly course and turns north 3 miles in an open valley of channel form, then after about 5 miles of winding course to the southeast, partly in narrow cuts, returns to the old glacial channel at Lyons. It is evident, both from the directions of the stream and the valley constrictions, that the course of the Ganargua was not followed by any large volume of the latest glacial drainage. Yet the study of these low passes and others eastward to Syracuse [pl. 4] suggests that their borders are usually too definite and direct and the entire form too channellike to represent merely the accidental, irregular, low areas among the drumlins. They seem to have been originated by stream work and partially obstructed by the later ice work. With this interpretation they argue for a complicated glacial history of the region and at least more than one epoch of heavy drainage. This point has been discussed in a former writing [*see* title 39, p. 427].

The Fairport channel lies so far north of and so far beneath the Victor channel that it suggests a distinctly different epoch of the drainage. We find that between the two series of drainage courses there are no intermediate channels, although the difference in altitude is 120 to 140 feet. In the higher series we find a succession of stream cuttings within a fall of perhaps only one or two score feet. A continuous recession and falling of the barrier implies a continuous lowering of the stream work. It seems conclusive that the lower channels, the Fairport series, were not cut by drainage of the same episode, or during one continuous recession of the ice front, as the higher or Victor series. It is also evident that the Fairport channel was made later and not earlier than the Victor channel, as it has not been overridden by the glacier since its occupation by a great river.

It is certain that the Victor-Phelps channel series represents drainage past the ice border long before Lake Warren came into central New York. It seems probable that the Fairport-Lyons series is post-Warren and post-Dana in time. If this is a correct interpretation it locates approximately the position of the ice front at this stage of the hypo-Warren (or hyper-Iroquois) time, because the directness of the drainage and its relations to the low passes on the north show that it lay near the ice edge.

If the reader will assemble in order plates 3 and 4 with the intervening Weedsport sheet, not here included, he will see that the Fairport-Lyons channel is continued east as a series of low passages which probably carried post-Warren flow, although their great breadth, their depth beneath the drumlins and their burial in silts indicate that they were not wholly excavated by the last ice border drainage.

In connection with the study of the water flow in its relation to the ice barrier it must be understood that the general down-slope of the land surface at the time of the glacier recession was as much greater than today by whatever amount the surface has been differentially lifted to the northward in postglacial time. The total amount of postglacial deformation is not closely determined in this region but the Newberry plane has been tilted between 2 and 3 feet to the mile.

The Pinnacle Hills moraine at the south edge of the city of Rochester with its northwestward continuation to Brockport, Holly and Albion, and its indefinite eastward extension through the townships of Penfield and Walworth seems to mark the location of the ice border at a time not far previous to the initiation of the Fairport channel.

On plates 2 and 3 the fragmentary phenomena of Lakes Warren and Dana are shown. Plate 2 shows the Warren shore line as occurring only south of the glacial channels, probably because there were no hights of land north of the channels up to the Warren plane, about 880 feet. But numerous cliffs and spits of Lake Dana occur at 700 feet, both north and south of the channels. On plate 3 are recorded evidences of both the water planes, but here we fortunately find the Warren phenomena north of the Victor channel, on the Baker Hill kame moraine. The occurrence of wave work by Lakes Warren and Dana north of the channels and at much higher levels seems conclusive proof that the lakes were subsequent in time to the last ice border drainage.

Another evidence of the later date and imposed character of Lake Warren is found in the nature of its shore-line features. At the Warren level in central New York there are no outwash plains or glacial deltas, which should have formed if these waters had laved the ice front during its recession from the higher ground. The phenomena at the Warren level are interpreted as either wave work or land-stream construction, and the weak planes are mainly erosional. The same conclusions apply to the Dana phenomena.

The detritus washed out of the glacier into the Warren and Dana waters seems to have been deposited as kames or indefinite forms, and may not be readily distinguished from deposits of the preceding waters. The Pinnacle kame moraine probably was deposited in sub-Dana waters [pl. 15–17] escaping by the Victor channel.

The Warren and Dana planes on the Baker-Turk hills lie about 20 feet higher than to the southwest, or at 900 and 720 feet. The cause of this greater altitude is not fully determined but is partly due to the northward position.

Cayuga depr ssion: Clyde channels

Between Clyde and Weedsport lies the axis of the broad north and south depression which holds Cayuga lake. On this parallel the lowest parts of the depression are occupied by the Montezuma marshes, the western branch of which appears on the map, plate 3. Savannah is situated on an islandlike drumlin group between the two branches of the marsh.

The swamp and its streams have an altitude of about 380 feet, which is 20 feet under the passes on the east and west. In consequence of this depression the stretch between Clyde and Jordan must have been covered by shallow lake waters during the time when glacial currents swept through the passes at 400 feet. As no positive stream cutting of the latest ice border drainage can be mapped between Clyde and Jordan the entire Weedsport sheet is omitted from our plates; but its insertion between plates 3 and 4 makes the plates a complete map of the belt from Batavia to Oneida.

The low areas and somewhat irregular passes in the stretch from Palmyra to Syracuse, having both north and south and east and west directions, must have been in existence before the episode of the latest glacial drainage, which we are studying. In some places, specially where the latest ice work had partially blocked the former passes, the later drainage work can be distinguished. On the meridian of Clyde the map indicates three later channels. Close and detailed study of the district may modify this map, and perhaps find other evidences of the later ice border drainage work.

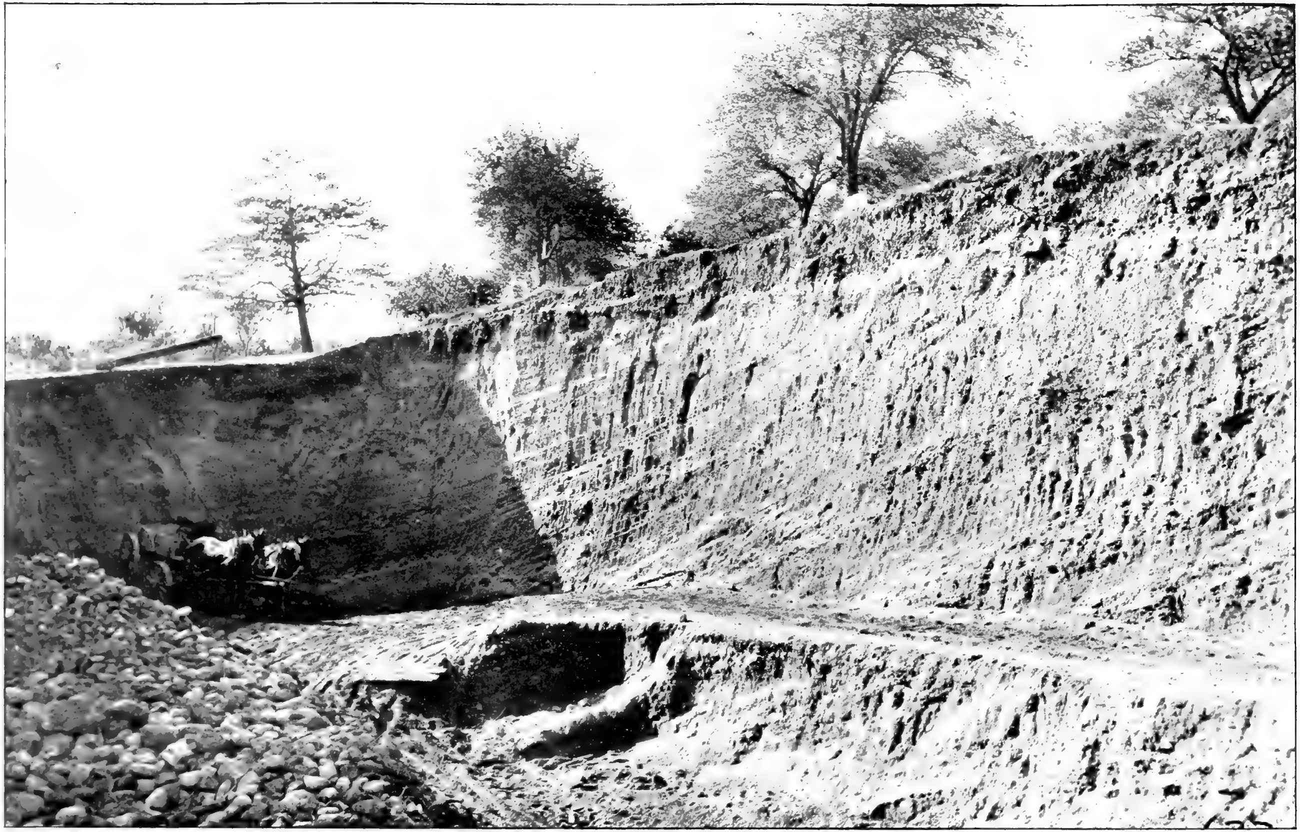
The swamp grounds in this region received the moderate volume of detrital matter which was carried by the rather sluggish drainage, and a few tracts which can be regarded as at least partly delta are designated on the map. The larger deltas are at

Plate 15

GLACIAL OUTWASH GRAVELS

Pinnacle kame-moraine, Rochester, N. Y. Near Erie canal widewaters. Looking southeast. Compare plate 16

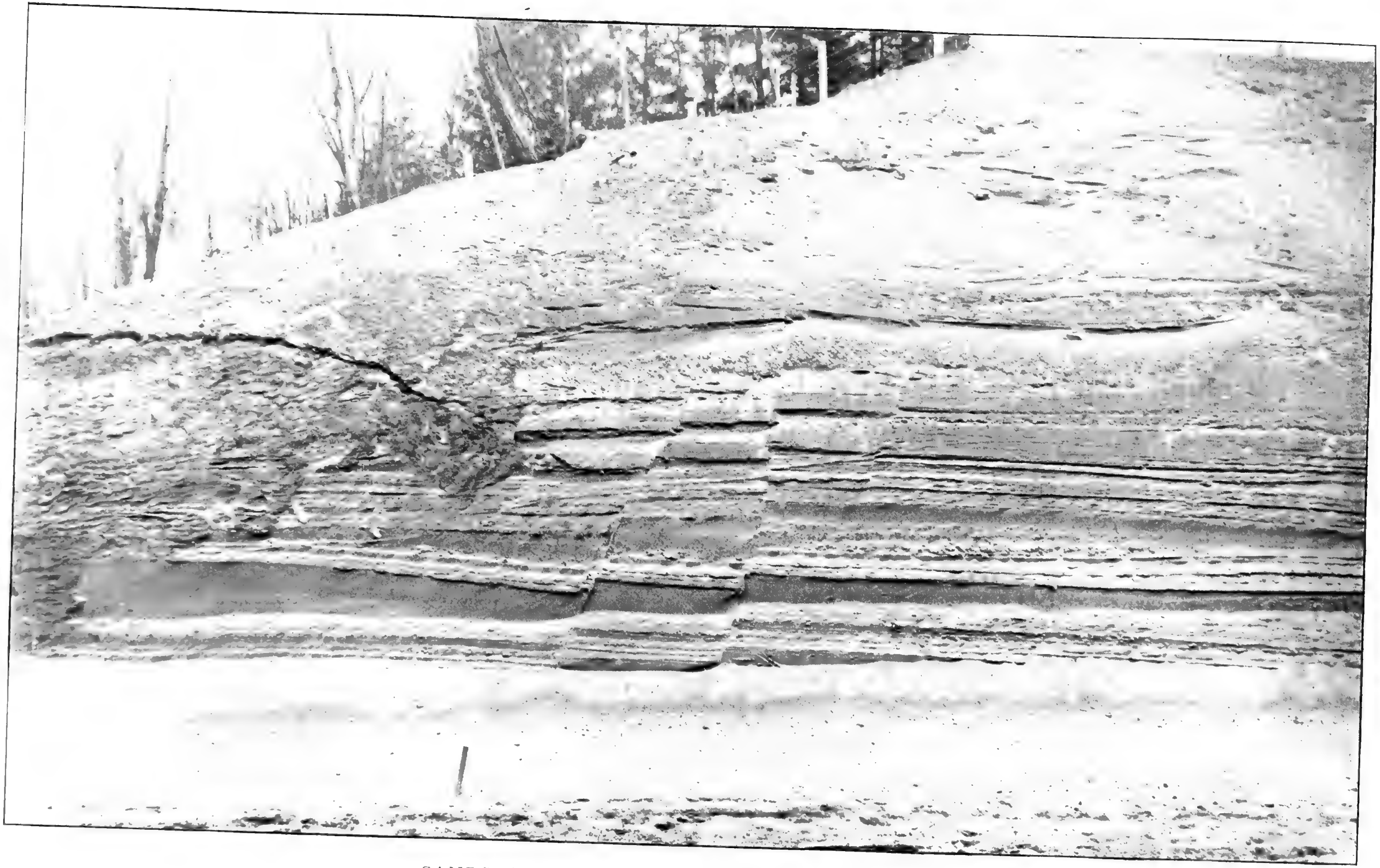
Plate 16



GLACIAL OUTWASH GRAVELS

Pinnacle kame-moraine, Rochester, N. Y. Davis pit, near pit shown in plate 15. Looking northwest

Plate 17



SANDS AND SILTS OF GLACIAL OUTWASH

Pinnacle kame-moraine, Goodman street cut, Rochester, N. Y. Looking east

Lyons and 3 miles southeast; and from 2 to 5 miles southeast of Clyde.

The problems of the glacial history raised by the relations of the drumlins to the open spaces and passes has been briefly considered in a former writing, describing the drumlins of New York [*see* title 39, p. 426].

Jordan-Skaneateles meridian to Syracuse

Early west-leading channels. Lake Hall

On plate 4 is depicted the more evident records of a complicated and remarkable drainage history, which can not as yet be fully translated with certainty. This is the critical district in the study of the glacial waters of central New York, since it was here that the ice sheet reposed the longest against the high ground of the southern plateau, and made its last efforts to block the glacial waters from eastward escape.

The reader will apprehend the main events in the history more readily if the fact is at once made clear that the channels west of the Syracuse meridian, as shown on plate 4, belong in three distinct episodes of the glacial drainage. In time order these are represented by:

1 The few and comparatively small west-leading channels, on the southern edge of the map.

2 The close-set series lying north of the parallel of Marcellus Falls, Howlet Hill and Onondaga Hill.

3 The two great channels east and west of Marcellus, corresponding to the latest occupation of the low passes west of Onondaga lake.

The reasons for the discordance between the chronologic and the geographic order will appear in the description following.

Earlier in time than even the first in the above outline was the overflow of the high-level glacial waters to the southward by the cols at the heads of the large valleys. This earliest glacial drainage being outside the scope of the present writing is not included in the field of the map; but will be found described in former papers [titles 16, 25].

When the ice sheet receded to the northward on the crests of the north and south ridges lying between the great valleys a westward escape for the valley lakes was opened toward Lake Newberry [*see* p. 8] and lower waters. The very lowest and latest of this episode are the two channels of group 1, leading to the Otisco valley.

Properly they do not belong in the present writing but are briefly introduced in this chapter in order to clarify the story.

Conspicuous deltas occur at the foot of Otisco lake, with their summit plateaus outlined by the contour of 940 feet. The streams which built these excellent deltas headed near Navarino and Joshua with bottom altitudes of 1140 and 1020 feet, and evidently carried westward the overflow of the ice-impounded waters of the Onondaga valley. Across the ridge east of the Onondaga valley we find a scourway at 1200 feet which carried the overflow of the Butternut valley over into the Onondaga and dropped its detritus 2 miles north of Lafayette at 1060 feet, correlating with the Navarino channel.

Looking to the west we find that the amber deltas at the foot of Otisco lake had their level determined by the hight of the overflow of the Otisco waters through a scourway 2 miles east of Skaneateles village with altitude of 940 feet. The westward outflow from the latter valley is below the field of this map, but lies at Mandana, close to the west shore of the present lake and 6 miles south of Skaneateles village, leading over to the Owasco valley, with altitude of 900 feet. Thus we find a perfectly consistent series of inflow and outflow of the glacial waters in the valleys from the Butternut westward to the Owasco.

Other west-leading channels at higher levels occur on the intervalley ridges, but they do not concern the present discussion.

The question comes, where was the ultimate outlet for these west-moving waters. In former writings it was supposed that Lake Warren was the receiving water, in central New York. But it has already been shown that the Warren waters did not invade this part of the State until subsequent to the drainage epoch represented by the east-leading channels already described, excepting perhaps the Fairport channel. The present writing is, therefore, a correction of the former supposed relation of Lake Warren.

It is apparent that the final escape of the waters must have been at a level not greatly over 900 feet, since that is about the altitude of the pass leading over to the Owasco valley. Only two possible outlets can be found. One is the Horseheads channel, at 900 feet, at the head of the Seneca valley, near the southern border of the State, the outlet of Lake Newberry; the other is the Batavia scourways, 900 feet altitude. The north and south deformation of the land since the glacial time has lifted the Newberry plane on the Skaneateles parallel not less than 80 feet above the outlet, or to

about 1000 feet. This forces us to the other alternative, the Batavia channels. To harmonize the phenomena it seems necessary to assume that the Batavia channels were effective while the ice front was yet lying against the high ground in the Syracuse region, and that all the waters bathing the ice front as far east as the Butternut valley, south of Jamesville, found westward escape. It is necessary to distinguish these waters with westward flow from the preceding Newberry lake with its southward escape and from the succeeding waters with eastward escape, and they are named Lake Hall, as already stated [*see* pl. 36].

Higher east-leading channels: Split Rock series. Lake Vanuxem

The two great channels lying west and southeast of Marcellus have heads or intakes so far beneath the level of the channels on the northeast, the Split Rock series, that it seems impossible for the waters to have been held at the hight of the latter if the Marcellus passes had then existed as low as they are today. For this reason it is believed that the Marcellus cuts were deepened to their present state subsequent to the cutting of the Split Rock channels. In chronologic order the higher and northward channels have precedence in our description.

The interesting succession of channels called the Split Rock series (named after the village and limestone quarry situated in the middle of the channels), lies on the limestone scarp southwest of Syracuse and extends from near Marcellus station, on the Auburn branch of the New York Central Railroad, eastward to Onondaga Hill and Elmwood Park. The most southerly and highest of the unequivocal channels is south of the hill crossed by the east and west highway 1½ miles southwest of Split Rock. This channel is in Marcellus shale, at an altitude of about 900 feet, according to the map contours. North of the hill and the highway the stream erosion has removed the Marcellus shale, and all the scourways down to the Split Rock gorge, or to about 750 feet, are in Onondaga and lower limestones. The bottom of the Split Rock gorge and all the channels northward are in the Cayugan (Salina) shales.

The Auburn and Syracuse Electric Railway traverses the channel district and affords a convenient way of obtaining a rapid view of the phenomena. Leaving Syracuse the electric line enters the broad, 400 foot channel at the west city line, passes through the deep gorge at Split Rock quarry, then climbs up along th[illegible] the scarp and swings around the brow of Howlet Hill i[illegible]cellus valley.

The north slope of the high ground west of Marcellus station, the latter situated at the mouth of the Marcellus or Ninemile creek valley, is also extensively benched and channeled by water flow that was synchronous with the Split Rock rivers. Locally the district is known as Lime Ledge.

All the stretch of water-swept limestone from Lime Ledge east to at least the Syracuse city line, a distance of 9 miles, has been affected by postglacial sinkage of the strata, similar to that in the Caledonia-Leroy district, described on pages 12–14. The dislocation of the naked limestones is conspicuous in the channels at Lime Ledge, and it may be clearly recognized from the electric railway throughout the Split Rock district. Immediately east of the Split Rock gorge, by the first road crossing, the Salina shales are so broken that it is not easy to discriminate the forms, whether produced by sinkage and dislocation, stream work, weathering of the soft rocks, or moraine remnants. West of the city in the low channel many mounds and subdued forms, at 420 to 460 feet, which resemble moraine masses are found to be remnants of the Salina (Camillus) shales left by the ancient stream erosion and modified by weathering. In the low channels both east and west of Syracuse the eroded and weathered Salina shales are easily mistaken for moraine. This is also true of some upland surfaces, specially noted in the Canastota-Oneida region, where the drift is scanty and the land surface has not been rubbed or drumlinized by the ground-contact ice [*see* title 39, p. 431].

There is no question that all the channels of the Split Rock series, as well as all the lower channels on the north, were carved by eastward water flow. The highest unmistakable cutting is the one already noted as lying south of the Howlet Hill-Onondaga Hill highway. On the north slope of Howlet Hill and on the brow of the hill to the west the surfaces are comparatively smooth, as if water-swept, across surfaces which the map contours make 920 to 940 feet. Theoretically it seems possible that such smoothing might have been done by westward flow into Lake Hall, toward the Batavia escape. There should have been westward flow on this meridian at all levels from the Navarino channel, 1060 feet, down to the level of the Batavia channels, near 900 feet. The successors to the Navarino channels are three or four small cuts across the nose of the hill southeast of Marcellus, at about 1020 down to 960 feet. The r[illegible] this meridian, terminating in Howlet Hill, would seem [illegible]een the critical and dividing line where the

ice-dammed waters hesitated or perhaps oscillated between east and west flow.

Passing by these equivocal features, we may say that the highest well marked eastward drainage in this district is at or slightly over 900 feet. Eastward, between the Onondaga, Butternut and Limestone valleys there are higher east-leading channels, to be mentioned in the next chapter.

The east and west deformation between Batavia and Syracuse, on practically the same parallel, is small, apparently 25 or 30 feet since Iroquois time. The close correspondence between the lowest passes south of Batavia and the highest at Split Rock is noteworthy, being in each case a little over 900 feet. Theoretically the Split Rock channels should be somewhat lower, and so they were when effective, or before the eastward uplift.

Three miles north of west of Marcellus is an interesting gravel plain, about a square mile in area, which includes the tract known as Shepard Settlement. It is a glacial delta or outwash by glacial streams from the edge of the glacier into standing water. On the north border the ground falls away steeply and with decidedly morainal surface, showing the ice contact. The altitude of the plain is 940 to 920 feet. The moraine forming the north side of the delta is a continuation of the Auburn moraine on the west, and seems to correlate with a belt of moraine surface which lies along the road south of the Split Rock channels. If this correlation is correct then we have located a considerable stretch of the glacier front at the time immediately preceding the initiation of the eastward flow by the highest Split Rock channels. The Shepard Settlement delta was apparently built in the waters of Lake Hall, and we thus locate the west-flowing waters far east and near the locality of subsequent eastward escape. All the relations of the several phenomena point to the history of lake and drainage as outlined above, namely that the lake waters west of the Syracuse region found westward escape at Batavia until the ice front gave way in the Split Rock district and then for a time, perhaps for many years, the central New York waters had double escape. flowing west past Batavia and east past Syracuse, either synchronously or alternately as the ice front slightly yielded or readvanced.

These waters at the ice front escaping eastward represent a lower level than Lake Hall and the opposite direction of outflow. They require a separate designation and are named Lake Vanuxem [*see* pl. 37].

Most of the higher channels of this series are shallow scourways in the limestone or only benches with low south banks. The limestone was too resistant to yield deeply to the lowering waters, but the gorge at Split Rock quarry (Solvay Process Company) and the channels east and north are down in the Salina shales and very pronounced.

The next chapter will make clear that we must postulate a readvance of the ice sheet that largely buried these channels, and subsequently with the final recession of the ice a reexcavation by the last drainage. In consequence of this repetition of stream work we can not discriminate the lower limits of the first drainage work from the second; but it must have been sufficiently low to carry the waters which cut the Victor-Phelps channels, which were under 500 feet. This seems to require that the ice should have uncovered all the land surface as far north as Jordan. Apparently all the east-leading channels depicted on the map might have been primarily excavated by the first or sub-Vanuxem drainage. The map shows the general features and relations of these channels and little further description is necessary.

The delta at Hartlot seems to have been built in glacial waters by land drainage through Skaneateles creek; which also contributed to the Elbridge delta.

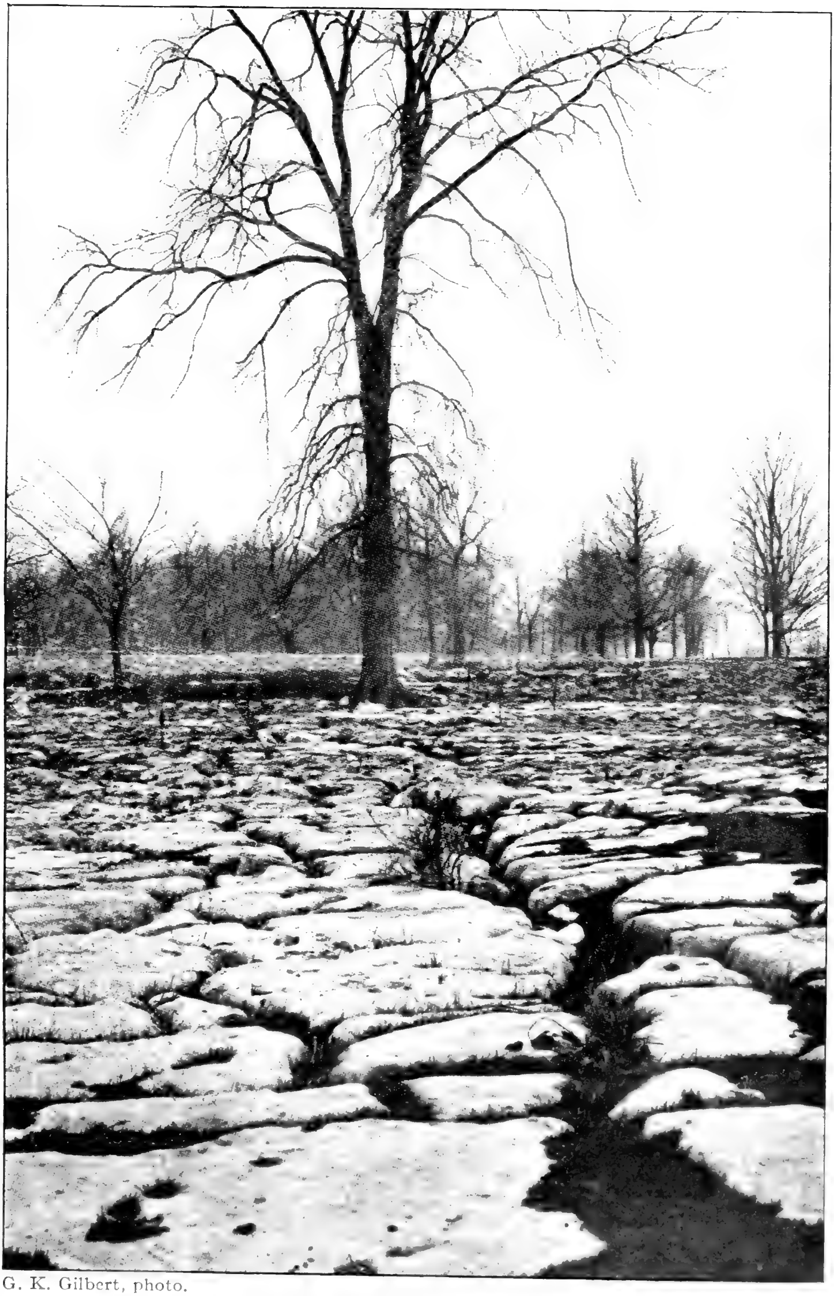
The swampy, broad, indefinite tracts followed by the railroads and Erie canal represent the lowest paths of the latest glacial drainage, probably the course also of the sub-Vanuxem drainage, and possibly a heavy flow past the on-coming ice during its invasion, or invasions, of the region. It has not seemed necessary to cover the broad low spaces with the designation or convention representing channels, as it is impossible to closely determine the limits of stream work or to separate it from lake action.

Marcellus channels: Lake Warren escape

These two great channels have been briefly described in a former writing [title 25, p. 53–55]. In that writing they were attributed to the flow of the falling Warren waters; and such is still believed to be their origin, though the present conception places them later in time than the channels, with higher altitude, on the north. The description of the channels will be in order, after which we may discuss their relations and history.

The western one of the two canyons is called, in lack of some geographic name, after the local appellation, the "Gulf." It

Plate 18



G. K. Gilbert, photo.

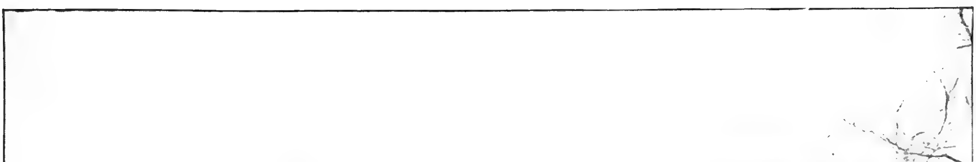
INTAKE OF GULF CHANNEL

Onondaga limestone 4 miles north of Skaneateles. Looking northeast (upstream)

G. K. Gilbert, photo.

Fig. 1 GULF CHANNEL

View looking southeast (downstream) near mouth of channel



G. K. Gilbert, photo.

Fig. 2 RAILROAD CHANNEL

Southeast of Syracuse. Looking northwest (upstream). D. L. & W. R. R. in background

heads 4 miles north of Skaneateles and a mile northwest of Shepard Settlement delta, at an elevation by the map of 820 feet. The bare limestone at the intake covers many acres, the appearance being well shown in plate 18, a characteristic view of a water-swept limestone surface. It is apparent that the great channel was not cut by merely local waters, for the features require the work of an enormous volume of water. The depth of the gorge is from 100 to 150 feet. The width of the bottom of the channel is from $\frac{1}{8}$ to $\frac{1}{4}$ mile, and the walls are flaring and not vertical, as the rocks are Marcellus shale [*see* pl. 19, fig. 1]. In the head of the gorge is a low cascade slope with two lakes (Mud Pond) at the foot. The altitude of the lakes is slightly under 800 feet and the decline of the channel bottom in the 5 miles to Ninemile creek valley is about 80 feet.

The map clearly shows how the channel widens as it joins the Ninemile (Marcellus) valley and ends in a huge fan delta. The currents of the heavy flood swung to the north through the narrow Marcellus lake to find their escape at Marcellus by the Marcellus-Cedarvale-South Onondaga channel. With the down-cutting of the latter gorge and consequent lowering of the Marcellus waters the inflowing river carved its delta into terraces with steep, curving fronts. These conspicuous erosion features on the delta can be plainly seen from the electric railway.

The highest portion of the delta, on the northwest side, reaches up to about 880 feet, and consists, as would be expected, of very coarse and poorly assorted material. The curving bluffs of erosion, representing the left-hand river banks, occurring at levels from about 860 down to about 760, mark the successive hights of the falling lake as determined by the Cedarvale outlet.

It is possible that some portion of the mass of the Gulf delta is moraine drift, as a heavy moraine lies against the delta on the south.

The body of water of small dimensions held in the Marcellus section of the Otisco valley during the life of the Gulf river has been named the Marcellus lake, it being the third in falling succession of the local glacial waters in the valley. The surface altitudes of this water were determined by the hights of the east-leading channel, the down-cutting of which accounts for the delta terraces and curving banks noted above.

The head of the Cedarville channel is at the southeast edge of the village of Marcellus, some 50 feet above the Ninemile creek,

and leads southeast with a width of $\frac{1}{4}$ to $\frac{1}{3}$ mile. The channel is in Marcellus shale except at the intake, where it reaches the Onondaga limestone. About 50 rods east of the north and south road which lies on the channel head the rock sill of the intake was cut into a cataract with a fall of about 30 to 40 feet. In the shallow and irregular basin below the cataract a lake of a few acres exists in the wet season, but is said to drain off by fissures in the limestone westward, under the cataract cliff, into the Ninemile creek [pl. 20].

The rock strata at the head of this gorge, as well as all through the region has a decided southward dip, with some flexures, the latter being well shown in the quarries in the channel head. On the north side of the intake the limestone is exposed and supports the highways, but on the south side of the intake the Marcellus shale is not entirely removed, being cut into three shallow channels with two intervening ridges, plainly seen from the north and south road. Taking as datum the United States Geological Survey bench mark on the coping of the bridge in the village, 653 feet, the elevations at the channel head are as follows: limestone at northeast angle of the channel head, over 700 feet; at the road corners, north side, 696 feet; channel in shale farthest south 685 feet.

The map shows better than verbal description the great ancient waterway, with its several branches and very extensive deltas. As a whole the channels and deltas are the most imposing among such features in New York State. The total length of the Cedarvale channel from Marcellus to the Indian Village in the Onondaga valley is nearly 12 miles, measured in its windings. All but the upper 3 miles lies in a broad preglacial valley which the river has largely filled with its delta rubbish; depositing first at the higher levels, then reexcavating and redepositing at lower and lower levels as the base level of the stream was lowered. The delta is of magnificent size and form even in its present fragmentary state. Erosion has left it in two distinct masses. The upper forms a great plateau south of Cedarvale post office, with two levels, the higher one declining in terraces from 860 feet (using the map contours) to 820 feet, the lower one being 680 to 660 feet. The preglacial valley, at least 2 miles wide on the Cedarvale meridian, must have been entirely filled with the delta, as fragments are found north of the Cedarvale channel and on the south border of the valley. That the present channel at Cedarvale, $\frac{3}{4}$ mile wide

Plate 20

CATARACT BASIN AND EPHEMERAL LAKE

Head of Marcellus-Cedarvale channel. Looking west (upstream). Basin is in Onondaga limestone.

in one section, has been excavated out of the former delta is proven by a conical mound of cemented gravel, over 40 feet high, standing conspicuously in the open valley a mile northwest of Cedarvale, a witness to the general filling of the old valley and the subsequent reexcavation by the falling drainage [*see* pl. 21]. The abundance of travertine in the mound suggests that the latter covers the site of an extinguished lime spring. This mound was noted, with correct interpretation, in 1842 by Vanuxem [*see* title 4, p. 247].

A stretch of open valley, ¾ of a mile square, from which the delta deposit has been removed, separates the Cedarvale portion of the delta from the larger and more scattered portion at South Onondaga and Indian Village. North and northwest of South Onondaga lies a mass over a square mile in area, the mesalike summit plateau having altitude of about 740 feet, with an eastern terrace of 670 to 660 feet; while the village lies on a 600 foot bench. A succession of erosion terraces with steep curving borders extend east and north for 3 miles, declining to the valley bottom of Onondaga creek at about 440 feet. South of the lowest channel, in which the west branch of the Onondaga creek runs, is a broad expanse of the delta filling in the higher part of the old valley, toward Cardiff, at altitude of 640 to 500 feet. The borders of the delta have received some contribution from the land stream drainage, a good illustration of which is seen south of South Onondaga where two small brooks falling 700 feet in 1½ miles have built deposits inclosing boulders in size up to 2 and 3 feet in diameter.

From some point of observation which commands a general view of the delta masses it is seen, much more plainly than the above figures for elevation indicate, that the many terraces or plains in the delta fall into three groups; the highest at 860 feet and downward, the middle (in altitude but not in geographic position) at about 750, and the lower from 680 down to 500 feet. These levels represent corresponding planes in the waters held in the valley, called the Onondaga Valley lake, and correlate of necessity with eastward outlets. We find these outlet channels on the ground southeast of Syracuse, as will be described in the next chapter.

Assuming that the great Gulf and Cedarvale channels were made by hypo-Warren waters it must be noted that the intake of the Gulf channel, 820 feet, is 60 to 70 feet beneath the plane of Lake

Warren. As there is no evidence of river work on the slopes south of the intake it appears that the initiation of eastward flow, the extinction of Lake Warren, was not in this locality. It is supposed that the Warren waters, standing over this district and creeping past the ice front, found initial outflow across one of the ridges on the east, possibly southwest of Jamesville, but more likely on the steep slope east of Jamesville, or between Fayetteville and Chittenango. Under this view the surface of the falling water was gradually lowered over the region until the river flow was established in the great channels described above.

Birth of Niagara falls and Lake Erie

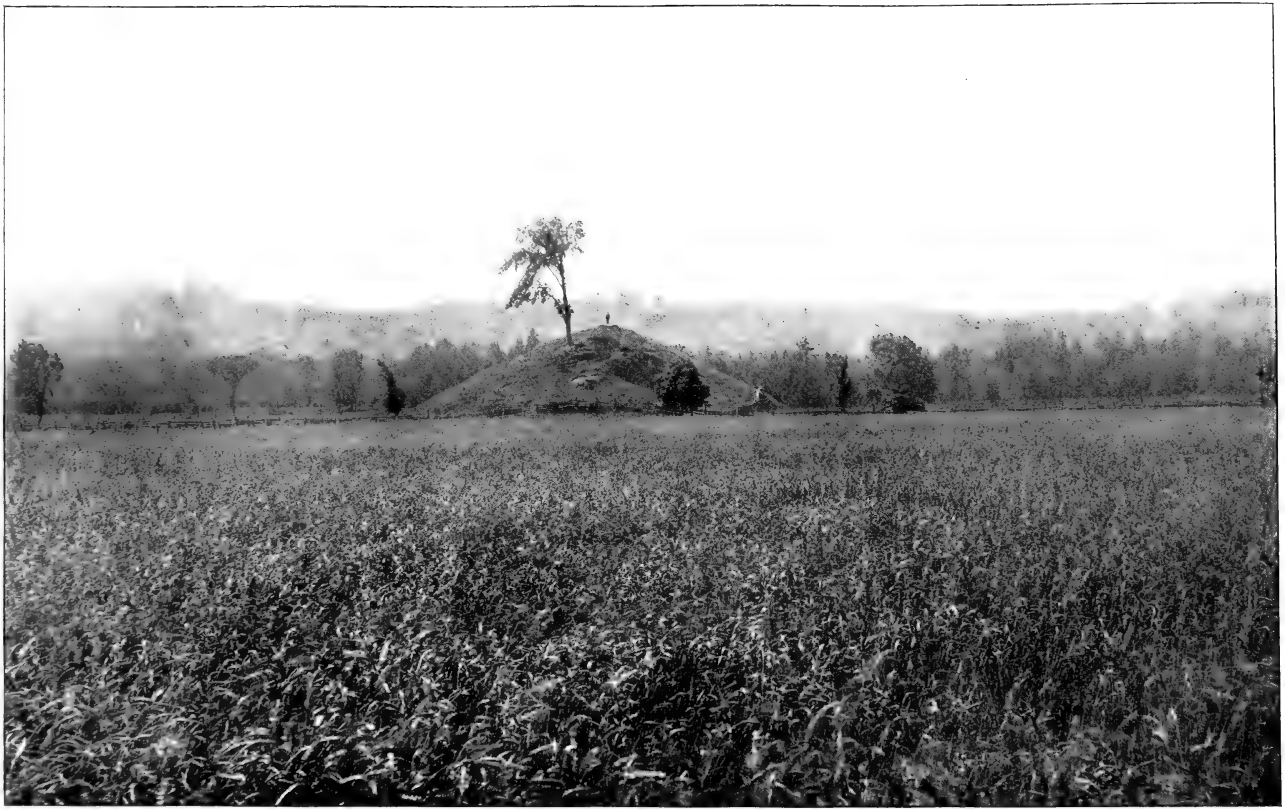
During the slow fall of the hyper-Iroquois waters and while the lower Syracuse channels were occupied the second time the falls of Niagara came into existence. While the Warren and Dana waters flooded central New York these glacial waters were confluent and identical over both the Erie and Ontario basins, as far as the ice barrier was removed. The separation occurred when the escarpment of Lockport limestone emerged from the subsiding waters, thus compelling the Erian waters to cascade over the cliff and drop into the now distinct Ontarian waters. The initiation of the falls and gorge of Niagara was coincident with the creation of the primitive Lake Erie.

Dr Gilbert long ago discovered that the first spilling of the Erian waters over the escarpment found at least two points of overflow, one at Lockport and the other at Lewiston, and that the latter did not prevail until a large gulf was cut at Lockport [*see* title 11, p. 286].

It must be understood that the waters lying north of the escarpment and restricted to the Ontario basin were not yet Lake Iroquois but only the sub-Dana or hyper-Iroquois. The crest of the escarpment at the two points of initial overflow has an elevation of about 600 feet. Allowing for eastward uplift the channel passing through Fairmount and Burnet Park seems to have held the earliest river which carried waters that had fallen over the young Niagaras.

The hight of the Niagara cataract could increase only as the surface of the hyper-Iroquois waters slowly fell. The control of the Niagara base level was therefore exercised by the ice barrier resting against the Syracuse salient, and later resting on the ground east of Rochester. The several terraces found at Queenston and along

Plate 21



REMNANT OF ANCIENT VALLEY FILLING

Lime-cemented gravel in Marcellus-Cedarvale channel, 1 mile northwest of Cedarvale. Looking south, across the great channel. Delta plain in background

the face of the escarpment have been given names and altitudes by Dr Spencer as follows [*see* title 42, p. 197]: Roy, 533, 521 feet; Eldridge, 446; Bell, 420. To make comparison with the eastern spillways we must add to these figures about 60 feet in order to bring the Iroquois plane at Lewiston into horizontality with the same plane at Syracuse. This makes the altitudes as follows: Roy, 593, 581; Eldridge, 506; Bell, 480 feet.

It is possible to select separate channel summits which have fair correspondence with the terrace levels, but precise comparison is not of value when we consider the downcutting of the outlets; the indefinite relation of the terraces to their respective water levels; the possible slight land warping; and the minor oscillations of the ice barrier. It is sufficient to note that the Niagara terrace levels range from 600 down to 477 feet and that the later hyper-Iroquois channels range from 600 down to the Iroquois level, 440 feet.

The excellent channel leading east from the Irondequoit valley, the Fairport-Palmyra-Lyons channel, with present altitude of 460 feet, was probably the latest channel, correlating with the Bell terrace. When this outlet was effective the Iroquois water was probably established at Syracuse, and the hyper-Iroquois restricted to the territory west from Rochester [*see* pl. 41].

The volume of water carried by the channels, which was not augmented by the interposition of the cataract, was comparable to that of the St Lawrence. The smaller land area then drained was probably more than offset by the supply from the extended front of the rapidly melting glacier.

Onondaga valley to Limestone valley

This relatively short stretch of 8 miles is in one respect the most interesting of all the channel districts, since it holds remarkable extinct cataracts and plunge-basin or cataract lakes. The lower and principal channels with the cataract phenomena have been briefly described in former publications by the State [*see* titles 27, 28]. Some new facts are given here, specially concerning the higher drainage, and the map, plate 4, depicts the earlier and higher channels and gives details which the former black and white sketches did not give.

This tract covers the north ends of two great north-and-south ridges separating three deep valleys. The sudden fall of the waters which cut across the ridge between the Onondaga and Butternut valleys produced steep ravines in the limestone and one mag-

nificent cataract, the Jamesville cataract and lake[1] [pl. 22–24]. Continuing their flow across the next ridge these waters cut a series of steep gullies and cliffs along the west side of the Limestone valley south of Fayetteville and west of Manlius. One cataract and lake, Blue lake [pl. 25], comparable in size to the Jamesville lake and rock amphitheater, lies 2 miles northeast of Jamesville, while another lake, White lake, lies at the junction of the Blue lake canyon and the east and west High Bridge channel. Descriptions of these cataract lakes were published in an earlier writing and details need not be repeated here [*see* title 27, p. 126–29].

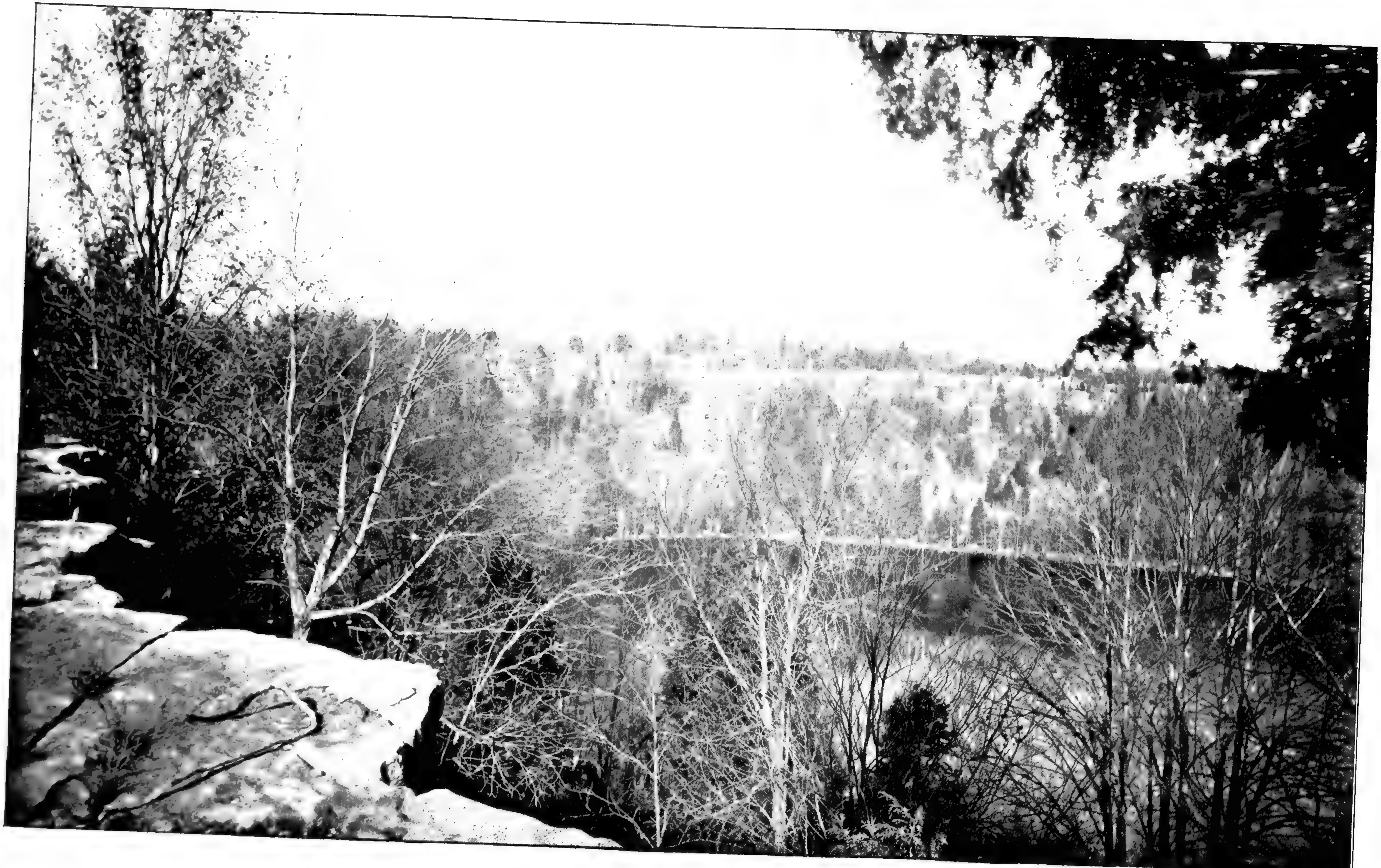
The larger and lower channels across the ridge between the Onondaga and Butternut valleys were described and illustrated in the former writings [titles 25–27]. The highest channel then recognized is the large canyon southwest of Jamesville, called the Reservoir channel, which is a deep gorge in the Marcellus shale, with a length of 3 miles, lying directly across the intervalley ridge. The altitude of the valley bottom is about 840 feet. Higher east-leading channels are now known, which are mapped on plate 4, and which are partly responsible for the circular depression formerly regarded as a loop of the Reservoir channel. The mass encircled by the glacial and recent stream flow resembles a drumlin in form, but is probably rock with a drift cap and has been shaped by the stream work and weathering. Still higher and somewhat indefinite cuts, reaching up to near 1200 feet, probably belong to an earlier time and carried local Butternut waters westward.

The most compact and remarkable set of cross-ridge channels lies north of the parallel of Jamesville. As they are all under about 800 feet they were probably originated by the outflow of the falling waters of Lake Vanuxem, and long subsequently were enlarged along with the Reservoir channel, by the much more copious waters of the falling Warren.

The lowest of the group is one of the most convincing illustrations of the work of ice-dammed waters, and in its form, preser-

[1] This lake has been described by E. C. Quereau in a paper numbered 44 in the bibliographic list. As three of the five lakes found in the Jamesville-Fayetteville district were locally called "green" lakes it was desirable to rename them. Dr Quereau renamed the one west of Jamesville the Jamesville lake. The similar lake 2 miles northeast of Jamesville the writer has renamed Blue lake [*see* title 27] since it is really a greenish blue color, and there is no near-by geographic feature to designate it. The name Green lake is allowed to stand for one of the plunge-basin lakes midway between Fayetteville and Kirkville.

Plate 22



CATARACT BASIN. JAMESVILLE LAKE

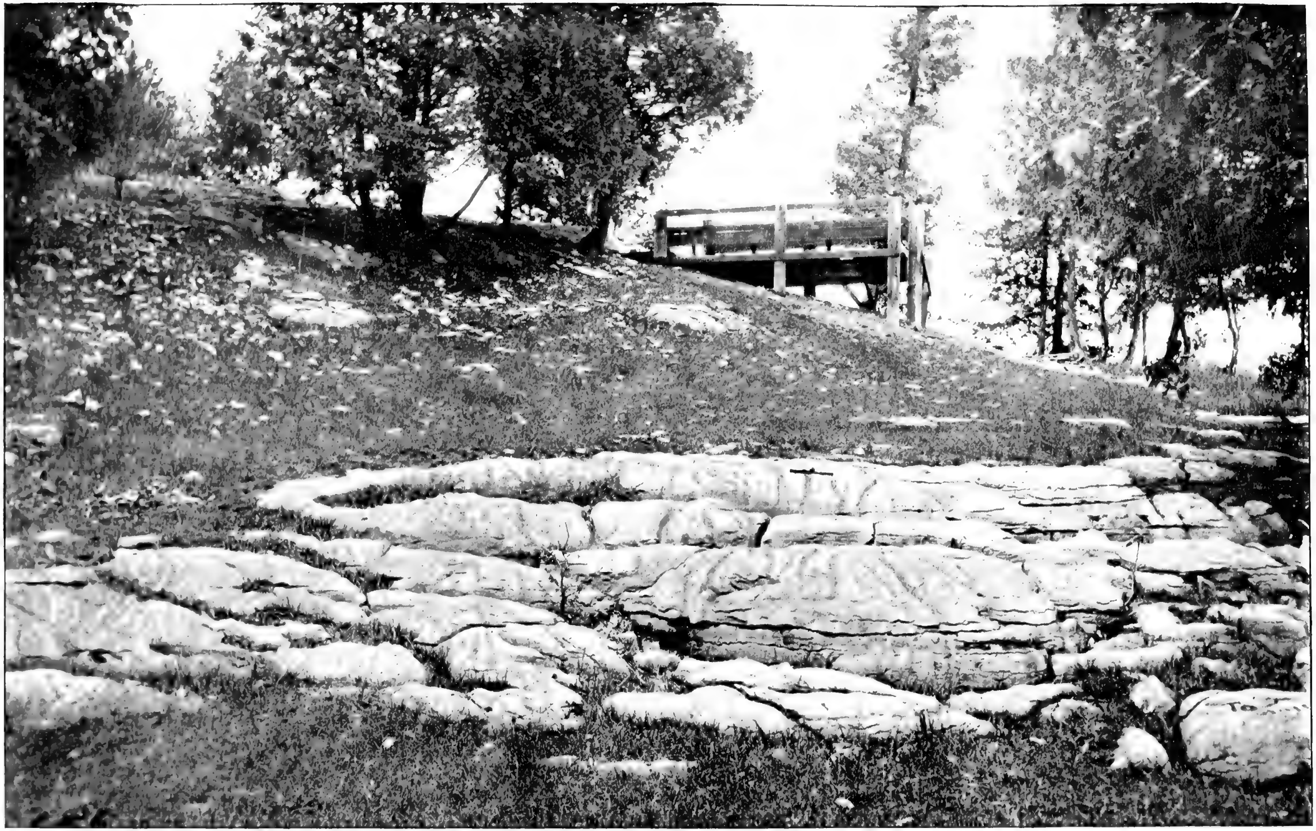
View looking across amphitheater from south crest. Compare plates 23 and 24

Plate 23

JAMESVILLE LAKE. ANCIENT CATARACT

Looking northwest, into the amphitheater. Compare plates 22 and 25

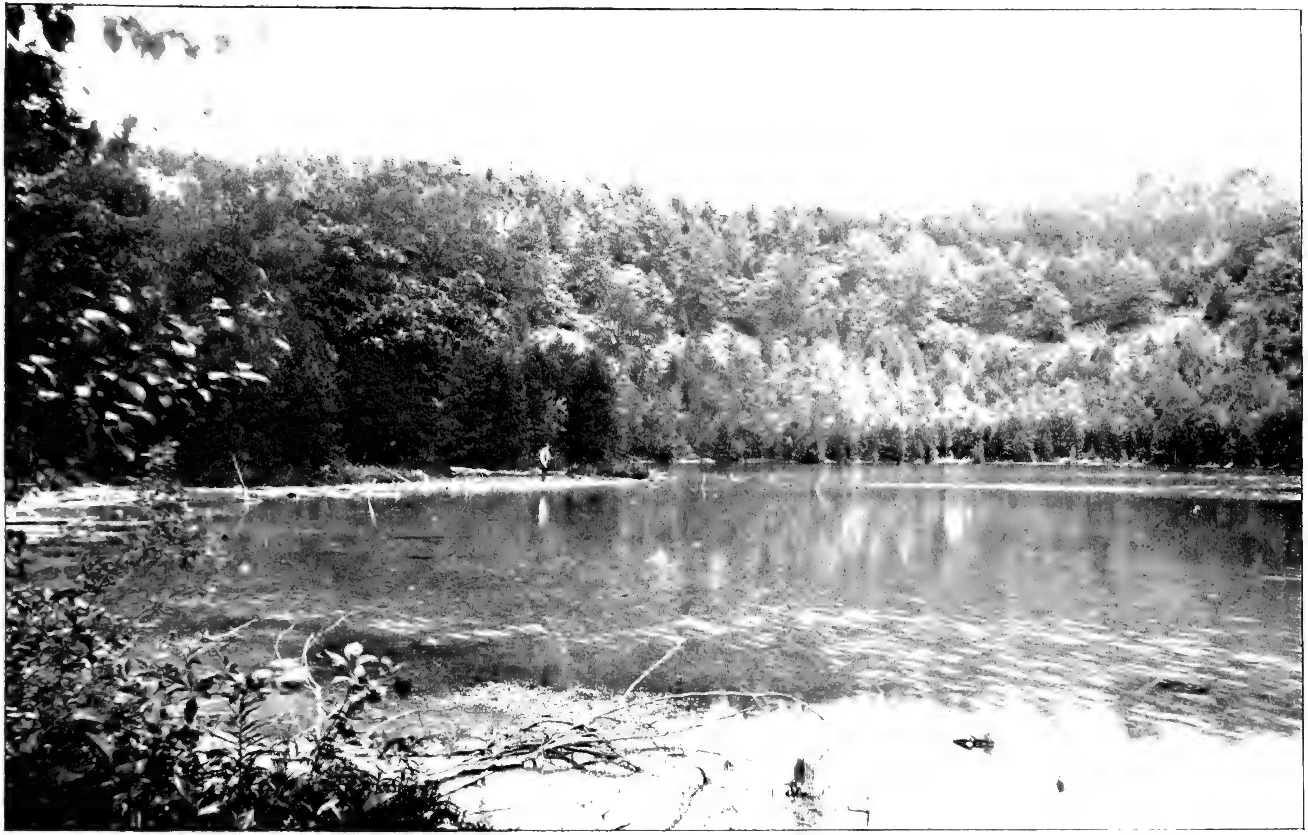
Plate 24



STREAM EROSION IN LIMESTONE

On south crest of Jamesville cataract. Looking northeast

Plate 25



ANCIENT CATARACT. BLUE LAKE

One and one half miles east of Jamesville. Looking southeast, toward the "horseshoe"

vation of features and accessibility to observation it is the handsomest glacial lake outlet channel in the State. The western end of the channel [pl. 19, fig. 2] is 3 miles southeast of the center of Syracuse, and the mouth of the cut forms a V-shaped gorge descending abruptly to the Butternut creek nearly 2 miles north of Jamesville. It is 2½ miles long, 800 to 1000 feet wide at the bottom, and 125 to 150 feet deep in rock. The nearly vertical bare walls of limestone have given it the local name of "Rock Cut," but since it is traversed by the Delaware, Lackawanna and Western Railroad, and is the only channel in the district so utilized, the name Railroad channel is more distinctive. Unlike the channels in shale, which are liable to be more or less V-shaped by the weathering and storm wash of the walls, merely the edges of the channel floor are covered by a talus. The floor is nearly level throughout, with an elevation of about 540 feet. Like the Reservoir channel it lies directly athwart the direction of the glacier movement, with both ends high in the air, the intake being 140 feet above the bottom of the Onondaga valley, less than a mile away.

The highest channel of this group is the stream-cut bluff lying along the south side of the road leading west from Jamesville, the highway resting on the rather indefinite terrace and the village being at the mouth of the shallow gorge terminating the channel. Close on the north is the canyon, cataract and lake which has been named after the village, which lies near the terminus of the gorge. Above the cataract, on the west, the limestone is worn and terraced in a manner characteristic of the swift waters of "rapids." The cataract is a semicircular amphitheater, perhaps 800 feet in diameter, with steep limestone walls 160 feet high. In the plunge-basin repose the green waters of Jamesville lake, 60 feet deep, about 400 feet wide and 500 feet long [pl. 22, 23].

Between the Jamesville canyon, 760 feet altitude, and the Railroad canyon, 540 feet, the rock is carved into a series of anastomosing channels and terraces, partially depicted on plate 4. Several plunge-basins occur in these channels, though none hold water permanently.

The large volume of delta rubbish which must have been produced by the excavation of the gorges in limestone is not found in large amount near the canyon mouths. A remnant of the boulder deposit from the Jamesville canyon is found at the northern edge of the village, and relics of the transportational work of the Railroad river lie either side of the valley road a mile north of James-

ville. The electric railway from Syracuse to Jamesville has a cutting through one of these delta fragments, as shown in plate 26.

The powerful floods of the falling waters excavated the earlier and higher delta deposits and rolled the huge boulders as well as the finer detritus to lower levels, northward, in the narrow Butternut valley. For a stretch of some 2 miles north from the mouth of the Railroad channel the valley seems to have been once filled to the width of a mile and to the depth of at least 100 feet near the head of the deposit. The most extensive remnant at the higher level is traversed by the east and west road leading to High Bridge. Lower fragments occur both sides of the valley as far as DeWitt; and a broad plain a mile northeast of DeWitt and alongside the Erie canal and its wide waters, with elevation of 440 feet, consists of coarse material and boulders up to 2 feet in diameter.

After the long weathering and soil production these coarse limestone deltas superficially resemble bouldery moraine; but dissection shows the water-worn and water-laid character of the deposit and the almost exclusively limestone composition.

The final erosion of the delta was by the lowest flow of the glacial waters and the more recent work of Butternut creek, and the material has been swept east and north to fill the low ground of the Oneida lake depression and Cicero swamp.

On this meridian, between the Onondaga and Butternut valleys, are found, certainly one and probably two more passes for glacial waters. Leading eastward from Syracuse to East Syracuse, and utilized by the several transportation lines going east, is a broad conspicuous channel, already described [*see* title 28] as the Syracuse channel. It is $\frac{1}{3}$ mile wide, and with present altitude as given by the New York Central Railroad levels of 415 feet. As it has been filled to some extent by accumulation of marl and peat its effective level was somewhat under the above figure.

North of Syracuse is a low, shallow valley, occupied by Ley creek, which connects the Onondaga valley with the low Oneida basin on the east by a divide near East Syracuse somewhat over 400 feet elevation, and toward Cicero swamp and Oneida lake by passes under 400 feet. When the ice front was in the neighborhood of Liverpool and the ice border drainage occupied the low pass by Jordan, Memphis, Warner and Amboy, the flow undoubtedly continued east by the depression of the present Onondaga lake and the Ley creek valley.

Plate 26

DELTA STUFF, OF GLACIAL DRAINAGE

At "Fiddler's Green," 1 mile north of Jamesville, east side of Butternut valley. Boulders are limestone derived from the railroad channel.

During the life of the Syracuse outlet the site of the city was occupied by a shallow lake extending south up the Onondaga valley, and fed by glacial waters from the west. The central and southern parts of the city are built on this detrital plain or delta built in the shallow Syracuse lake, which deposits also form the present floors of the low channels at Syracuse. These plains are at least 20 to 30 feet beneath the Iroquois level. The valleys in their deeper sections are not the erosional work of the later glacial drainage but antedate the epoch which we are studying, and as passes between the drumlin masses they are part of the problem involving all the lower channels from Palmyra to Syracuse [*see* p. 20].

In the preceding chapter the terrace levels on the Cedarvale South Onondaga delta were referred to the levels of outlets to the eastward, and we find these correlating outlets in the Jamesville series of channels. The following comparison of the levels of terraces and outlets will show the relationship.

PRINCIPAL TERRACE LEVELS ON CEDARVALE-SOUTH ONONDAGA DELTA		ALTITUDE OF OUTLET CHANNELS, JAMESVILLE SERIES	
Upper terrace	860–840	Reservoir channel	840
Mesa terrace	±750	Jamesville channel	760
Middle terrace	660		
South Onondaga terrace	640–600	Unnamed channels	700–600
Lower terrace	560	Railroad channel	540
Lowest terrace	500	Syracuse channel	400

In such comparison we must remember that the channels have suffered deepening, and that we find them with the depth attained when the river saws abandoned their work. We can not generally determine the amount of down-cutting by the stream, but no channel can be initiated at a level higher than the bottom of the antecedent and deserted channel. Another uncertain element is the relation of the lake surface to the delta terrace. A third element is the land deformation, which may not be neglected when the features are on far separated parallels. The east-west deformation in this district is small, but there may be a northward uplift of 2 or 3 feet per mile. In the above figures there is a lack of precision as they are estimated from the map contours and may vary a fraction of 20 feet, but accurate measurements will confirm the

close correspondence between the delta levels and the channels, as there can be no question of their genetic relationship.

The channels which carried the glacial flow eastward from the Jamesville district over to the Limestone valley are quite as conspicuous and interesting as those just described. As shown by the map there are a large number of distinct notches or gashes across the steep scarp between Jamesville and Manlius, the higher ones being in Marcellus shale with one lake and fossil cataract, Blue lake, rivaling the Jamesville lake and amphitheater. The Blue lake gorge leads north and joins the High Bridge channel, which is the only channel extending directly and entirely across the land between the two valleys. Three miles east of Jamesville and 2 miles southwest of Manlius is the head of an interesting ravine, with a cataract cliff about 100 feet high and an amphitheater about 50 rods across. The bottom of the ravine is a smooth meadow with two levels. The upper level is about ½ mile long, the surface being a smooth floor of fine detritus. The lower end of this meadow drops off abruptly 20 feet to another meadow, about 20 rods wide and ½ mile long, opening to the valley of Limestone creek a mile from Manlius village.

The Blue lake channel heads at about 780 feet and was cut by water in continuation of the flow of the earlier stage of the Reservoir channel. The flow through the Jamesville canyon was carried eastward by the notches cut in the scarp northeast of Jamesville and the earlier stage of the High Bridge gorge. The latter channel is a direct continuation of the Railroad channel, and the altitudes of the two channels are the same. However, since the Railroad channel ends with a deep V-shaped gorge the later flow must have found the eastward escape lower than by the High Bridge channel and therefore poured northward down the Onondaga valley, plowing away much of the earlier delta. This fact is evident on a glance at the map which shows that the Railroad channel carried all the east-flowing glacial waters until the ice front had receded 3 miles, or to the Syracuse outlet.

The production of cataracts on the west side of each valley in this region proves that the waters stood much lower in each valley, successively, than in the next valley on the west. Such discordance of the water level could not have existed if the ice front had extended in an east and west direction across the ridges and valleys. Instead of that the ice front during its last stand in this locality was part of a convexity or lobe which gave here a north-

east by southwest trend to the front, and thus allowed a sharp fall from one valley to the next one on the east.

The highest channel on the ground between the Butternut and Limestone creeks mapped in the former writings was the " Green's " channel, lying along the south side of the highway leading from Jamesville to Manlius, with altitude of about 900 feet. The present map, plate 4, represents slightly higher drainage. Much higher on the slope are cuts and scourways apparently produced by westward flow. These occur from 1 to 2 miles south of Green's channel, reaching about 1300 feet altitude. These features seem to show that even the Limestone valley waters were once tributary to Lake Newberry or Lake Hall.

The delta fragments in the Limestone valley are quite as extensive as those in the Butternut valley. They extend from Manlius northwest to below Fayetteville, on both sides of the creek, and are suggested on the map. A large remnant lies close west of Manlius and east of the creek, consisting of very coarse material and with altitude of 560 feet. A smaller fragment lies on the west side of the valley with coarser material and higher elevation since it represents the head of the original deposit. The largest fragment is northwest of High Bridge, with summit altitude of 600 feet. Some sections of the Limestone valley must have been filled clear across with the limestone rubbish, similar to the filling in the Butternut valley, with subsequent excavation of the deposits and the removal of the material northward into the low grounds.

Limestone valley to Chittenango valley

The map, plate 4, shows how completely the north-facing slope between Fayetteville and Chittenango has been swept by stream flow held betwixt the ice and the rock. On the meridian of Eagle hill, the line separating the counties of Onondaga and Madison, the whole slope is eroded, not less than 12 trenches or terraces in limestone occurring within the space of 2 miles, ranging from 1100 feet down to 500 feet [*see* pl. 27]. On the lower ground lie four more channels, in Salina shale, the lowest being a cut bank south of the Erie canal and its wide water, at the altitude of about 440 feet.

Theoretically there was some higher overflow, up to 1240 feet, as this is the altitude of the lowest of two notches west of Cazenovia lake which permitted the Limestone waters to pass eastward over to the Cazenovia and Chittenango valleys, to find further escape along the north side of Cranson hill as shown in plate 5.

The lowest channels in this district and eastward are conspicuously represented by the banks or bluffs which formed the south walls of the rivers. These are plainly seen in many places between Syracuse and Oneida from the New York Central and the West Shore Railroads, and have been described and illustrated in a former paper [title 28]. Facing the bluffs are the smooth, level surfaces that formed the floors of the latest glacial rivers of the region, and which prepared, as if purposely, the graded stretches for the canal and railroads. For considerable distances between Manlius Center and Canastota the Erie canal uses the old river bluffs for the south bank.

On the west flank of the Eagle Hill mass the water work is evident over all the saliences of the slope, but is not readily mapped. The direction of the scourways indicate the existence of an ice lobe or tongue in the Limestone valley extending up to Manlius, and beyond, and producing a curving flow of the waters around the slope north of the village. The West Shore Railroad northwest of Manlius lies along the lowest terrace.

Only one decided cataract has been found; lying 2½ miles east of Fayetteville near a north and south road, but without any lake. The drift rubbish below the cataract resembles moraine [pl. 27]. On the steep slopes southwest of Chittenango the waters cut ravines and gorges with cascades.

Two and one half miles northeast of Fayetteville are two lakes, Round and Green lakes, lying in the course of a river channel excavated in Salina shales. On account of the nonresistant character of the strata the lake basins and the valley have sloping sides and the plunge-basin origin of the lakes is not so evident as in the case of Jamesville and Blue lakes. The Round and Green lakes were probably once united but accumulation of travertine and peat has produced division.

A large volume of delta material must have been swept into the narrow Chittenango valley, north and south of the village, but mostly or entirely removed by the present stream. The absence of delta convention on the map south of the village must not be regarded as final, as close examination has not been made. Northwest of the village and north of Mycenae considerable areas are buried under stream detritus.

In the channel followed by the road between Fayetteville and Mycenae, Pools Brook hollow, are clusters of low knolls along the valley sides which might easily be mistaken for moraine, but which

Plate 27

CANYON OF GLACIAL RIVER

The "Basin," 2 miles northeast of Manlius. Looking northeast (downstream) from crest of cataract

are only weathered remnants of the soft Vernon beds of the Salina. It should be noted that the forms have smoother and more graceful surfaces than moraines, and that there is an almost entire absence of boulders and foreign material in the fields. In the plowed fields and stream gullies the bright green and red colors of the Vernon shales appear.

Chittenango valley to Oneida valley

The stream phenomena of this region are depicted in the map, plate 5.

This west-to-east stretch of about 12 miles includes two great ridges, Cranson hill and West Stockbridge hill, with a deep, narrow, intervening valley, Cowaselon creek or Lenox valley. The Cranson hill is on the meridian of Canastota and the West Stockbridge hill on the meridian of Oneida.

The earliest and highest channel found on the Cranson hill ridge lies a half mile southwest of the village of Perryville with a conspicuous delta plateau close to the village. The channel, which seems to have been overlooked by the topographers, is in shale, ½ mile long, 100 feet deep and with a width of bottom of 175 to 200 feet. The delta covers several acres, with two terraces, and with abrupt wall facing the village. The altitude of the channel is about 1200 feet.

The channels of the Cranson hill series proper lie on the steep slope within a belt 2 miles wide on the meridian and 6 miles long east and west. The highest channel begins ¾ mile northeast of Perryville and determined the upper level of the Perryville delta [pl. 20]. It is a winding cut in Hamilton shale with altitude of about 1230 feet, and continues around the hill as a cut terrace at about 1200 feet. The character of the stream cutting in the limestone is shown in plate 29. The lowest and longest channel in the series is down in Salina shale and forms an east and west valley nearly 5 miles long. The west half of the channel is utilized by the Elmira and Cortland division of the Lehigh Valley Railroad, while the east half of the channel is occupied by the Clockville creek, the upper waters of which come down the escarpment from the south. The village of Clockville lies where the north and south ravine bisects the east and west glacial channel.

Between the Clockville channel, altitude 800 feet at the intake, and the Canastota scourway, about 430 feet, a breadth of 2½ miles, there are four channels. These occupy the low passes in the Salina plain.

The Canastota channel is occupied by the two railroads, and the south bank of the ancient river is the conspicuous bluff close to the railroad station [see title 28, p. 143].

The channels on the West Stockbridge hill are fewer than on the Cranson hill, but stronger. The map shows that they have a decided curvature about the nose of the hill, indicating that lobes of ice front occupied the Cowaselon and Oneida valleys while the drainage followed the reentrant angle in the ice front on the ridge. The two southernmost channels lie on the crest of the ridge and on the south-facing slope of a limestone knob, a relationship which is singular and not understood.

One large delta has been mapped, west of the Oneida Community and south of Oneida Castle. This extensive deposit is composed largely of debris from the Salina shale in which the lower channels are cut, and the weathering and storm-wash have so dissolved and eroded the delta that in form it resembles a moraine. It is very possible that some moraine drift is buried in the delta.

The Cowaselon valley is so narrow and steep-walled that the living creek has removed the material which must have been swept into it by the Cranson hill drainage. However, the map is probably deficient in not indicating some delta deposits at Lenox and Wampsville.

DELTAS

Principles in delta construction

The many detrital deposits built in quiet waters by the contributions of the ice border drainage have been noted and briefly described in the preceding pages in connection with their correlating channels and water bodies. A few points in theoretical discussion, with application to the field under present study, will be helpful to students of the phenomena.

Theoretically, delta deposits should be expected to occur whereever a vigorous stream debouched for considerable length of time into standing water; but they are often lacking, and the question arises whether the absence of the delta is due to failure of formation or to subsequent removal.

In the study of deltas a variety and combination of modifying conditions must be considered, which may be grouped under three heads:

A Conditions relating to the stream work.

B Conditions pertaining to the delta area, or the physiography of the receiving basin.

Plate 28

GLACIAL STREAM CHANNEL

One mile northeast of Perryville. Looking east (downstream)

Plate 29

WORK OF ICE-BORDER DRAINAGE

Limestone bed of glacial river, north of Perryville. Looking eastward (downstream). The south bank of the river appears in the background at right.

Plate 30

MODERN STREAM WORK

Deserted bank on north side of Black river, 4 miles northeast of Watertown. Looking southwest (downstream). (Introduced for comparison with ancient drainage as shown in plates 11, 18 and 29)

C Changes subsequent to the formation of the deposits.

(*A*) The transporting ability of a stream is a function of its velocity and volume; but as streams are seldom full loaded the actual work done in the way of supplying delta material depends not only on the ability of the stream but on the quantity and quality of the detritus supplied to it. Probably none of the glacial streams represented by channels depicted on our maps lacked power to carry all the finer detritus supplied to them, but in a few localities where the flow was sluggish, as indicated by the low gradient and lack of definition in the channels, we find the stream beds littered with boulders which the currents had been unable to roll any further. Examples may be found in the indefinite channels between Victor and Phelps.

The delta-forming materials were derived from several sources: (1) Detritus from land drainage, contributed by tributary streams; (2) contributions by the glacier drainage or the outwash from the melting ice sheet; (3) glacial drift, the rock rubbish received directly from the ice by those streams which laved the ice front; (4) the glacial drift moraine and kame, which the ice and its drainage had left within reach of the stream; (5) the bed rock encountered by the stream in its down cutting, which in many cases was the most important supply.

As the streams along the ice border were cutting across ridges, between the great valleys, they did not commonly drain extensive land area and consequently received relatively small contribution from tributary streams. The land-stream drainage was mainly concentrated in the larger valleys, which held glacial lakes, and which were the catchment areas for both the land-stream detritus and that of the proglacial streams. The best examples of ice border rivers with tributary land area are: at Leroy, receiving Oatka creek; at Honeoye Falls, receiving Honeoye creek; at Manchester, receiving Canandaigua inlet.

The ice border streams received their detritus mainly from two sources: (*a*) glacial drift, contributed by the melting ice front and by the streams draining the glacier, and (*b*) the product of the corrasion by the stream on its own channel. Probably the drift borne by the ice sheet had unequal horizontal distribution, and certainly the glacial drainage concentrated the drift at the points of issue or debouchment of the streams. The tendency of the streams draining the glacier to follow the valleys or land depressions beneath the ice sheet resulted in the piling of the stream detritus by the

glacial outwash mainly in the low grounds where the ice border drainage could not usually reach it. The extensive kame areas in the Genesee valley and those named the Mendon, Irondequoit, Victor and Junius [*see* title 20] are deposits formed at the ice edge and not removed.[1]

The proglacial streams naturally swept along all the ice-contributed and the ice-stream-contributed drift that came within their grasp, and little evidences of such supply would be left alongside the channels. The evidence which can be found is the considerable proportion, in some delta masses, of rock materials of northern origin, such as crystallines, Trenton limestone, Potsdam sandstone, etc. A few boulders and many cobbles of northward origin are likely to be found in all deltas, as practically every stream must have found some glacial material, either directly from the ice, or from moraine deposits along the channel sides, or contributed by land wash from the southward.

In the majority of pronounced deltas the greater part of the mass consists of material derived from the excavation of the stream channel by the corrasion of the stream itself. The amount of preglacial and glacial deposits which the stream has removed in any particular section before it could attack the rock strata could hardly be estimated, but the amount of rock cutting is quite clear. In the cases of the gorges and canyons, like the Gulf, Marcellus and Railroad channels, the large volume of rock excavation is evident, and it could be calculated approximately by measurements. The deltas at the mouths of such gorges will have a composition like the wall rocks of the canyon, and a mass proportionate to the channel excavation, provided of course that the delta has not been eroded. Sometimes the large volume or hight of the delta is the main evidence of large erosion by the stream, as in the Cedarvale-South Onondaga delta, the channel being V-shaped on account of weathering, and equivocal. Another interesting fact is that narrow north and south valleys, like those at Jamesville

[1] It should be understood that the kames (mounds of gravel and sand) are essentially deltas in the manner of their origin, being formed at the mouths of streams pouring out of the ice sheet. But they usually lack the form of deltas because of the inconstant character of the stream channels, these being walled in ice, and the shifting of the points of debouchment. Rarely in this region the glacial deltas are broad and flat, as sand plains or glacial outwash plains. One example has been described [p. 25] as the Shepard Settlement plain, another at East Bethany, Genesee co., and yet another in the same county near Darien station [*see* title 37].

and Manlius, were entirely filled with delta rubbish so that the streams swept the later detritus clear across a valley into an eastward basin. In such case the delta may represent the cutting of two or more channels on the west.

The character and size of the delta depends not only on the amount of stream erosion but also on the nature of the excavated rock. To some extent limestone is removed in solution and the shales are largely reduced to so minute division that it is borne far away. The rock strata encountered by the proglacial streams described in this paper do not include any sandstones. The higher channels, stratigraphically, are in the Marcellus shale; the middle ones in the Onondaga and upper Salina limestones; the lower ones in the lower Salina (Camillus and Vernon) shales. The deltas are found to have pronounced characteristics, dependent on the nature of the materials. Examples will be cited later.

(*B*) The building of a delta at all, and the form and extent of the deposit, depended somewhat on the topography or form of the receiving basin. When the western wall of the basin was a gentle slope the condition was favorable to the construction of broad delta plains, even of finer material, and for their preservation, like those in the Genesee valley. When, on the other hand, the receiving basin had a steep western wall, like the valleys east of Syracuse, this was unfavorable to lodgment of the detritus near the lake level, specially of the finer material, and a moderate volume of material might leave no visible delta.

If in addition to the steepness of the wall the valley is narrow and V-shaped, like those at Jamesville and in the Chittenango-Oneida district, the deposits even if large in volume may be subsequently removed.

(*C*) The changes to which the deltas have been subjected since their formation are: (1) weathering; (2) storm-wash; and (3) stream corrasion. Weathering and storm-wash have little effect on deposits of gravel or sand, and are not rapidly severe on calcareous material. It is surprising how quartzose sand deposits, beaches or deltas, have preserved their perfection of form through all the vicissitudes to which they have been exposed in the thousands of years since they were made.

If, however, the deposit is shale rubbish and therefore clayey, or even with considerable admixture of silt, then it may suffer decomposition and erosion. The delta in the Oneida valley is an excellent illustration, and the one northwest of Geneva one of less degree.

Deltas of coarse limestone rubbish, like those in the Butternut and Limestone valleys [*see* pl. 26, 31], may have accumulated a soil, which along with the frost work on the boulders, make the irregular and perhaps eroded surface resemble moraine. (It should be remembered that all these deposits have been covered with forests, which facilitated decay and soil production.)

The chief factor in the modification of the deltas has been corrasion by the later proglacial streams and their successors, the valley streams. As described earlier in this writing, the deltas of coarse limestone rubbish which once must have filled the Butternut valley at Jamesville, have been largely removed and the material swept down the creek (northward) to form extensive deposits on the edge of the Oneida lowland. In the cases of the narrow valleys on the east the same sort of work has been done in even greater degree. The excavation of the deltas was at first by the later flow of the same streams which had built the deltas, as the ice barrier receded and the base levels of the streams were lowered, and since then continuously by the existing valley streams. The lake waters in the steep-walled valleys had a minor destructive effect. as the agitation of the lowering waters tended to shift the detritus down the steep slopes.

With the principles of formation and destruction of the proglacial stream deltas before us, as outlined above, we will now review the several delta tracts in order from west to east.

Description

Genesee valley. The deltas are extensive in the Genesee valley, though the mapping, plate 2, is somewhat hypothetical as the limits are difficult to determine, even on the ground. These deltas are too broad to be conspicuous in appearance, and they blend into the uplands. At a few points their delta structure, specially the foreset beds, are grandly shown, as in the great gravel excavations at Scottsville, Canawaugus and intermediate pits [*see* pl. 7–9]. The gravels are a mixture from several sources, but those at Scottsville have a preponderance of Salina material, in which the correlating channels are cut, and are consequently of poor quality for road metal though they answer better for railroad ballast. The limestones were not deeply cut in the district west of the Genesee, though a few short gorges with cascades lie north of Leroy, and the delta material is not very coarse. The width of the Genesee valley is so great and the west wall so gently sloping that the delta deposits found favorable conditions for building and for preservation.

Plate 31

DELTA RUBBISH OF GLACIAL DRAINAGE

Two and one half miles north of Cazenovia, at crossing of Chittenango creek. Looking north

Rush-Mendon. The delta near Fishers built by the Rush-Mendon series of channels is well defined and not seriously eroded, though not as large as might be expected from the size and length of the stream channels. It seems probable that most of the detritus of the higher channels was partially or largely dropped in the low places along the stream courses, while that of the lower channels being Salina shales has been reduced by grinding and the product carried far away.

Victor-Phelps. The ice-border rivers in the Victor-Manchester-Clifton Springs-Phelps channels [pl. 3] had low gradient and small carrying power. They were mostly on the limestones and secured little detritus by their own corrasion. Probably a large portion of their load was used to fill low places along the stream courses and grade the channels; an illustration is the sandy plain northwest of Manchester. The final deposits of this 20 odd miles of stream flow form the somewhat anomalous and extended delta between Phelps and Geneva. This deposit of gravel and sand has a decided slope to the east and grades east and south into silts, as if it were a veneer on the valley slope. The direction of the channels and the trend of the delta seems to indicate that the ice front occupied the ground on the east. The sub-Warren waters at a later time held possession of this district, and lake silts and dune sands are spread over the surface toward Waterloo. The delta has been much gullied by storm-wash and largely eroded, as shown by the map contours, to a degree unusual for a sand-gravel deposit.

Fairport-Lyons. The splendid channel between Fairport and Lyons has no commensurate delta. For reasons already given it seems probable that the depressions occupied by the later streams were cut by the ice border drainage of an earlier ice invasion. The channel is in drift and the soft Vernon shales of the Salina, and the product of the stream corrasion in rock was not of delta-making character. Moreover such detritus as the stream obtained was spread over the low grounds in the swampy tracts to the eastward, specially along the Clyde river, beyond Lyons and southeast of Clyde.

Elbridge district. The deltas at Hartlot and Elbridge [pl. 4], as noted on page 26, seem to be chiefly the product of land drainage, by the Skaneateles outlet.

Marcellus valley. The excellent delta in the Marcellus valley at the mouth of the Gulf channel is small in area relative to the great rock channel. It is composed largely of coarse limestone derived from the intake district, and has suffered little erosion by post-

glacial agents. The gulf canyon is mostly cut in Marcellus shale and the clay detritus has been swept far on toward, or into, the Oneida lowland.

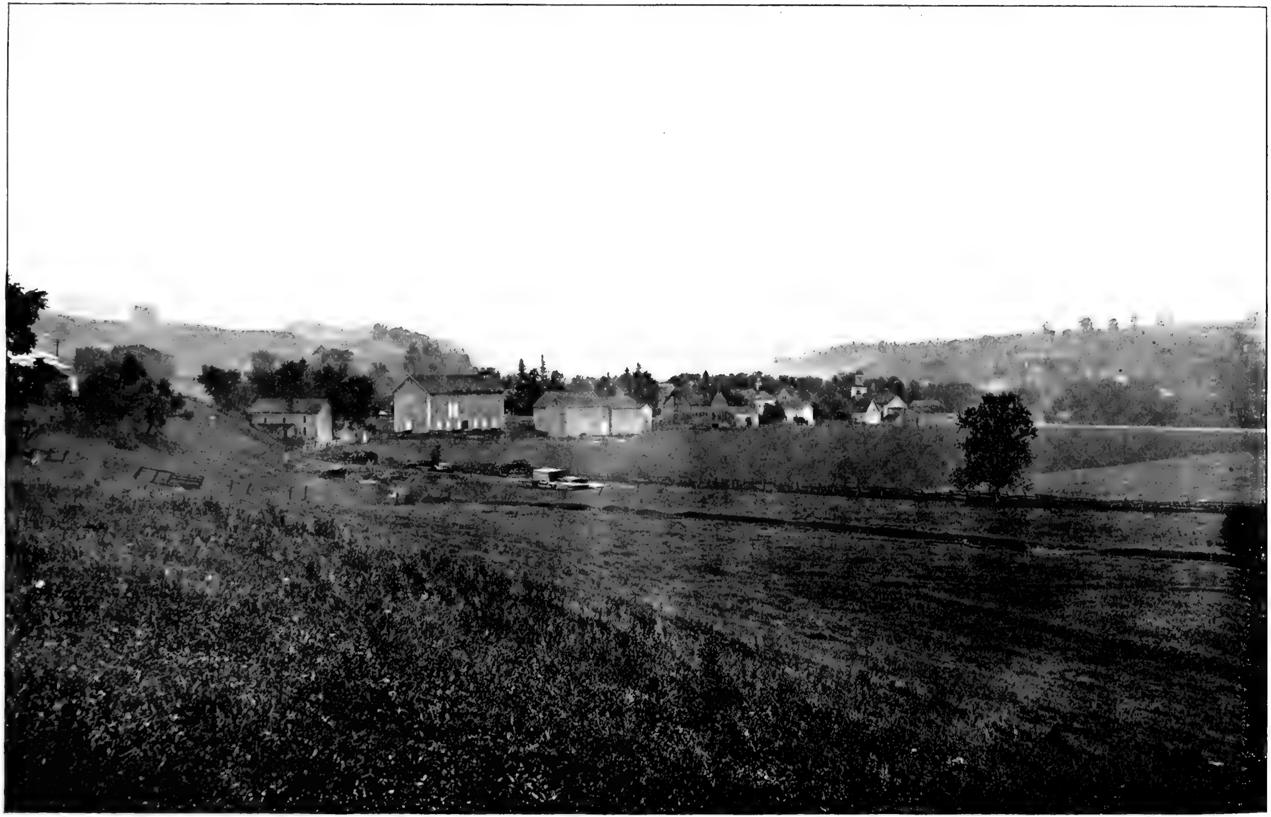
The Gulf delta is an excellent illustration of the excavating and terracing work of the river on its own deposits, produced by the lowering of its base level, as the eastern channels drained the lake waters.

Onondaga valley. The massive deposits of the Cedarvale-South Onondaga delta have already been described at some length [p. 28]. The delta tract as mapped would indicate an extent and volume of detritus beyond the amount of rock excavation suggested by the Marcellus gorge, specially as the latter is in shale. It seems probable that beneath the river deposits is considerable volume of glacial (moraine and kame) drift which the ice sheet left in the broad valley lying transverse to the ice movement; and possibly some of the broad terraces are partly erosional in drift instead of entirely constructional from stream detritus.

These great deltas were carved and reshaped by their own waters, but they seem to have much the forms with which the glacial waters left them, as subsequent activities have modified them but little. They are so vast and varied that some student of the district will find them an interesting and profitable subject for detailed work.

The many and conspicuous channels in the Split Rock district and west of Syracuse have little delta, apparently, to show for their work, the reasons being manifold. The upper channels are on the limestones and did not cut deeply. The lower channels are in Salina shales which do not contribute delta stuff. The west wall of the Onondaga valley is too steep to afford good lodgment. The coarse and heavy detritus was carried down to the bottom of the deep valley and the later, finer detritus spread over it. The valley lies at a low altitude and was occupied by Iroquois waters, and opening broadly to the north the wave work might have been effective below about 440 feet. The Onondaga creek has long been effective as a distributor of the low-lying detritus. It is probable that the silt from the South Onondaga delta and most of the detritus from the Onondaga Hill, Elmwood Park and Split Rock channels has been swept into the valley bottom to make the extended plain on which stands the city of Syracuse. The low grounds in the district of Onondaga lake must have a veneer of stream detritus over the glacial drift.

Plate 32



CAMILLUS CHANNEL

One of the lower channels in the Syracuse district. Altitude 420 feet. Looking southwest (upstream)

Butternut and Limestone valleys. The higher channels of the Jamesville district are in shale and therefore not favorable to deltas. The canyon of Jamesville lake and the Railroad channel supplied a great volume of limestone boulders which entirely filled the narrow Butternut valley for some distance north from Jamesville. This deposit was partially removed by the powerful currents of the lowering rivers and redeposited at lower levels farther north. The vigorous Butternut creek has aided in this work, but its burden has been carried farther out on the Oneida lowlands.

The facts briefly noted above for the Butternut valley deposits apply without important qualification to those in the Limestone valley, at Manlius and Fayetteville. The coarseness of these deposits, their large proportion of limestone, the irregularity of the surfaces, and the resemblance at first sight to bouldery moraines, are striking features.

Chittenango and Cowaselon valleys. The scouring of the limestones on the north face of Eagle hill is very pronounced, though the cutting is not extreme. The writer has not made sufficiently close examination to say that no delta fragments rest against the west wall of the valley opposite the higher channels, but the map [pl. 4, 5] clearly shows the absence of any large delta. The only deposit which has been recognized is on the low ground north and west of Chittenango, and belongs to the Pools brook and Mycenae channel. The explanation would seem to be that the deposits thrown into the Chittenango valley by the higher proglacial drainage have been rolled down the steep slopes by the postglacial storm waters and seized and swept north by the present creek.

A similar statement and explanation applies to the valley south of Canastota, and to the Cowaselon valley above Wampsville. The flat areas at Lenox seem to be Vernon shales, but some of the ground north of Wampsville should probably be marked as delta [pl. 5].

Oneida valley. The detritus held by the lowest proglacial drainage in the Chittenango-Canastota district was probably carried east past the valleys considered above and finally dropped in the Oneida valley. However, the broad delta south of Oneida Castle seems to correlate with the channels on the west, in Salina shales, and to be mainly composed of shale rubbish. It has been eroded by storm-wash to such degree that it has the aspect of a moraine,

but from favorable points of view the original plain of the delta can be recognized.

Oneida lake lowland. It seems likely that considerable areas of the lowlands east of Syracuse and north of the channels shown on plates 4 and 5 are more or less filled with deposits largely derived from the latest proglacial streams and from the deltas left in the north-leading valleys. The distribution and leveling of the materials on the plain may be largely referred to the waters of Lake Iroquois, which for some thousands of years stood here at an altitude marked today by gravel bars and spits with altitude of 440 to 450 feet. The later land drainage has also spread its load of detritus over the Iroquois bottom or carried it into Oneida lake.

Theoretic succession: summary

Theoretical succession of deposits. An ideal vertical succession of the various deposits in the district from top to bottom would be somewhat like the following, although in any actual section some numbers would be wanting and numbers 3 to 6 would be commingled. In order of time the deposits are the reverse of the numerical order.

1 Modern vegetal accumulation; peat

2 Marl, in places beneath the peat

3 Flood plain silts from post-Iroquois land drainage

4 Iroquois silts from land drainage

5 Iroquois gravels, sands and silts from erosion of glacial deltas

6 Gravels and sands directly from the glacial outwash and proglacial drainage

7 Till, ice-laid drift, directly from the glacier

8 Modified drift, gravels, sands etc., by lakes and streams during the later ice advance

9 Probable deposits, both ice-laid and water-laid, of an earlier ice invasion, perhaps a Pre-wisconsin glacial epoch

10 Geest, or products of preglacial rock decay, in place

11 Sound or live rock

Resume of delta characters. If the reader or student would examine one of the deltas which might be misinterpreted, or perhaps mistaken for moraine, he might well visit the one west of High Bridge and a mile south of Fayetteville; or the one just west of Manlius; or the one across Butternut creek from the Railroad channel; or any of the terraces in the Marcellus, Cedarvale

and South Onondaga district (as moraine drift is probably buried in these latter deltas special care may be necessary here).

His diagnosis will begin with the most obtrusive feature, the exceeding stony character of the fields. Perhaps the boulders are so large and so abundant that the surface has not been put under cultivation, like much of the delta opposite the Railroad channel. If the ground has been plowed then stone walls or fences (often a superfluous number) will likely be seen, and perhaps cairns or piles of the unused cobbles. Closer observation will reveal some degree of uniformity in the size of the stones in a restricted locality; also that they are more rounded than the ordinary stones from drift. In most of the deltas cited there is a decided preponderence of limestone, with only a small percentage of foreign material.

Noting the general form of the deposit, it will be found (if it has not been affected by subsequent erosion) to have a generally level or moderately undulating surface, quite unlike a morainic mass. In case of extremely coarse materials the delta plain might not be well developed, and erosion is possible in any case, though this produces terraces or gullies and never kettles. Toward the valley side terraces may be found with steep frontal slopes and smooth, curving horizontal lines, natural to stream erosion. Rarely on the north side of a delta the banks may be found very irregular, having been banked against the ice front, and so exhibiting the unusual constructional form of the "ice-contact."

If the position, altitude and material be referred to surrounding topography and characters, it will surely be found that the deposit has relation to some stream channel on the west. It may be some distance beyond the mouth of the channel, or near the mouth, or possibly alongside the channel which has cut through or past the delta. The altitude may not have close relation to the producing or inflow channel, but more likely to some outlet channel eastward, and possibly miles away, which determined the level of the lake waters.

In some cases of deltas of wide extent, kettles or basins may be found, which are best explained by the melting of buried ice blocks; it being supposed that in the waning of the quiescent ice front detached blocks of the stagnant ice, even of great size, might be sometimes buried in the massive stream deposits.

Usually deltas are readily distinguished by their correlation to the producing channel, but sometimes careful discrimination is required. The element most likely to be uncertain is the limits,

which in subaqueous deposits of fine material are likely to be indefinite.

OSCILLATIONS OF THE ICE FRONT: WARREN WATERS

With the above descriptions of the stream and lake features before us, it is now in order to seek the explanation which will harmonize the phenomena. A brief statement of the theoretical sequence of events was given in the introduction, but we can now elaborate some points and give a fuller account of the principal episodes in the history.

Two main facts stand out clear: first, that all the channel series from Leroy to Phelps, and all except perhaps the lowest at Syracuse, were made along the receding ice front. Second, that the Warren waters do not belong in the same episode as the channels, but that they invaded central New York long afterward. The distribution and vertical relation of the phenomena seem to permit no other conclusion.

The above conception implies, as a corollary, that the glacier, acting as a barrier, must have been adjusted to such positions as were necessary to produce the phenomena. We are required to assume some advance and retreat or oscillation of the ice front, at least in the Syracuse region, and a degree of seesawing of the ice front as between the meridians of Batavia and Syracuse. Certainly the ice barrier had to recede or back away and open low passage through Syracuse and eastward in order to allow the river flow which cut the channels. It is equally certain that when Lake Warren subsequently occupied central New York, at about 880 feet altitude, the Syracuse passes were closed [pl. 33]. But while the ice front was readvanced at Syracuse, so as to hold back the Warren waters, it was necessary in order that the waters could enter central New York at all that the ice barrier should recede in the Oakfield district.

It is seen, therefore, that we have two critical localities; one north of Batavia, near Oakfield, and the other in the Syracuse district, probably the steep slope west of the city in the district of Howlet Hill and Split Rock.

On the Split Rock meridian we find all the channels or stream flow features which the theory requires, the only undetermined feature being the hypothetical belt of moraine which might be expected to mark the limit of the ice readvance during the Warren episode. This evidence has not been diligently sought, and should

be slight since all the slope below 700 feet has been swept by the sub-Dana escape. In connection with the Warren overflow and the Dana level we will recur to this point later.

The phenomena in the western critical district are not so satisfactory. The Warren shore line lies along the crest of the Onondaga scarp from Indian Falls around to east of Batavia, at about 880 feet. The most northerly point and the highest on the beach is near the "Pond" triangulation station, 3 miles west of Oakfield, with altitude 887 feet. In this curving stretch of about 16 miles the beach phenomena are interrupted but positive, and show the lake altitude. When the ice sheet receded from the salient between Oakfield and South Byron there should have been a rush of water either east or west through the pass, unless there was a practical equality of level in the two water bodies either side of the opening, which is not impossible. The ice sheet was certainly holding the Warren waters in the Erie basin, and if the waters in central New York were much lower than the Warren then the rush of Warren waters through the new opening would have produced erosion channels below the Warren plane. On the other hand, if the ice front at Syracuse had previously readvanced and closing the east-leading passes had raised the central New York waters to a level above the Warren plane, or possibly created a second Lake Hall, then with the opening of the Oakfield pass the higher waters would have cut west-leading channels at a level above the Warren plane. But no channels have been found which answer to either case. The land surface from Indian Falls around to Morganville, east of Batavia, is irregular with drumlin and moraine drift, both above and below the Warren plane, which the Warren waves have not seriously affected. There are stretches of steep slopes and ledges beneath the beaches which might suggest river banks, but they do not have the directness or continuity of strong channel walls, while wave work was certainly present there. It is the writer's judgment that the moraines in the district are pre-Warren in time and that no stream cutting lies across the salient. It seems certain that the Warren waters invaded central New York at their full level instead of rushing in to occupy vacant territory.

Looking at the possibility of westward flow of waters superior to Warren we see that central New York waters could not stand higher than Lake Hall, slightly over 900 feet. The total possible fall from a second Lake Hall down to the Warren was only about 20 feet.

A suggestion can be offered to account for the absence of channels on the salient. It has already been stated that it is morainal territory. East of the salient and northeast of Batavia is a heavy moraine, traversed by the New York Central Railroad, with kettles and kettle lakes. To the north and northeast the land declines gently. It seems altogether probable that when the ice weakened at this locality it was not by recession of a bold and stream-swept front but by ablation and thinning over a wide belt; and that the draining of the second Lake Hall, or the waters under that level, down to the Warren plane was through stagnant and drift-buried ice, and consequently no channels are preserved.

Warren outflow

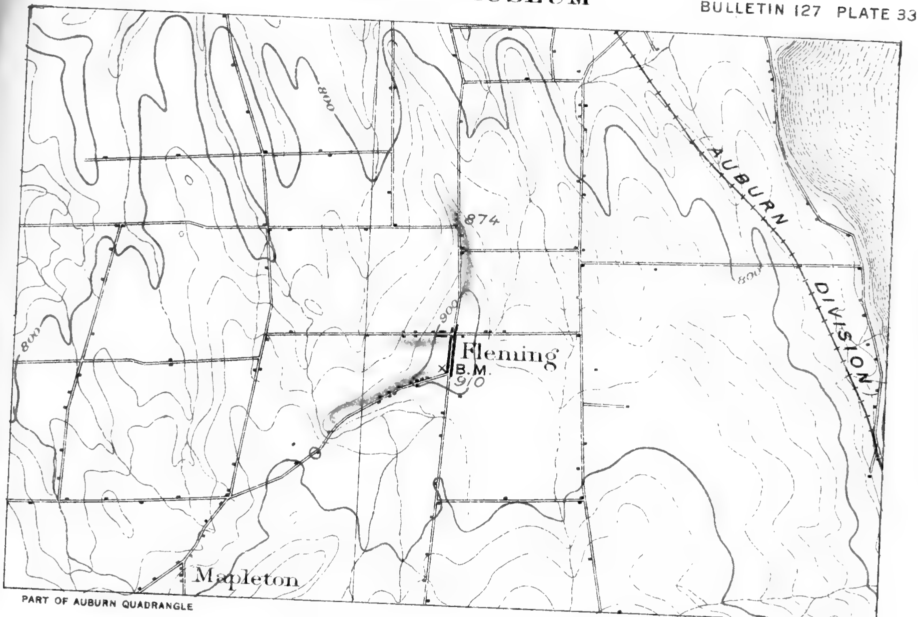
With Lake Warren admitted to the Ontario basin let us again turn our attention eastward, to the locality of its extinction, the critical district in the region of the Split Rock channels and the Gulf and Cedarvale canyons.

Our problem in this district is the production of the great canyons on the south (west and east of Marcellus) and yet subsequent to the higher (Split Rock district) channels on the north.

By a glance at plate 4 the reader will understand that the glacial waters could not have been held up to the hight of the highest channels on Howlet Hill and Split Rock if the great passes at Marcellus had then existed in the form which they exhibit today. We are forced to the conclusion that the Marcellus gorges are of later production than the Split Rock channels. The simplest explanation is to attribute the two great gorges to the overflow of the vast Lake Warren, and subsequent to the Vanuxem waters.

The single but sharp difficulty which we have to meet under this theory is the original hight of the Marcellus passes. When the outflow of the Vanuxem waters cut the Split Rock scourways, from 900 feet downward, the Marcellus passes must have been over 900 feet. But the later Warren waters could not have used them for outflow if they were above the Warren plane, about 880 or 890 feet. This difficulty of the altitude of the Marcellus passes is quantitatively slight, but positive.

The suggestion is now offered of a temporary filling of ice and drift in the Cedarvale-South Onondaga valley which held the pass at a high level during the life of Lake Hall and the early Lake Vanuxem. The ancient valley was sufficiently capacious



PART OF AUBURN QUADRANGLE

LAKE WARREN BARS

Five miles south of Auburn

PART OF GENEVA QUADRANGLE

LAKE DANA BARS

H.L.Fairchild 1906

Six miles south of Waterloo and Seneca Falls

WARREN AND DANA BARS IN CENTRAL NEW YORK

to have held large masses of stagnant and possibly drift-buried ice, and the two sections of the valley lie so transverse to the direction of ice movement that they could readily entrap the edge of the waning ice sheet. This is not a violent nor unreasonable hypothesis, and it offers a simple and apparently the only way out of the dilemma, unless the Pleistocene history of the region is much more complex than outlined in this writing.

Lake Dana

The sub-Warren waters have been named hyper-Iroquois for the reason that they had the same ultimate escape as the Iroquois waters and were tending to the Iroquois level. The great canyons in the Syracuse region should have held the lake waters at certain levels for sufficient time, it would seem, to have produced recognizable shore features in central New York. However, the only plane of the hyper-Iroquois waters which has been found is that of Lake Dana [title 22 and pl. 2, 3], which has throughout central New York the quite uniform altitude of 700 feet [pl. 2, 33].

The only strong channel in the eastern district which could today hold the waters at near this level seems to be the Marcellus-Cedarvale canyon. To freely reach this outlet the waters must have had access to the Marcellus (Ninemile creek) valley from the north. Confirmation of this relation is found in the hight and form of the erosion at Lime Ridge, east of the head of the Gulf canyon and 3 miles northwest of Marcellus village. Under about 800 feet the limestone scarp is deeply cut into benches and channels which curve around the slope into the Marcellus valley. It would appear that when the waters of the lowering Warren fell away from the intake of the Gulf channel they flowed around the salient at Lime Ledge, and that they continued to occupy the Marcellus valley and the Cedarvale channel. This waterflow implies that the ice front had here a trend somewhat northwest by southeast; and this relation seems probable, since the drumlins indicate that during the last drumlin-making episode a lobe of the ice pushed to the southeast over the depression of Onondaga lake and Syracuse.

With the down-draining of the hyper-Iroquois water below about 700 feet, the intake of the Cedarvale canyon, the only escape was on the north slopes of Howlet hill and Split Rock and below that hight these slopes must have been water-swept the second time; and any moraine left there by the readvanced ice should be looked for above that altitude.

Theoretic lake succession[1]

In conformity with the above theory of the lake and drainage history the succession of the larger glacial lakes would be as follows:

	Lakes	Approximate altitude on the Batavia-Syracuse parallel
1	Watkins, (Horseheads outlet, 900 feet)....	
2	Newberry (expanded Watkins)..........	1000± feet
3	Hall....................	1000± down to 900± feet
4	Vanuxem.................	900± down to extinction
5	Episode of free eastward drainage and no lakes	
6	Second Vanuxem...........	rising toward 900± feet
7	Warren..................................	880 feet
8	Hyper-Iroquois, Lake Dana................	700 feet
9	Hyper-Iroquois, Lake Dawson............	480± feet
10	Iroquois................................	440 feet

Description of the maps of glacial lake succession

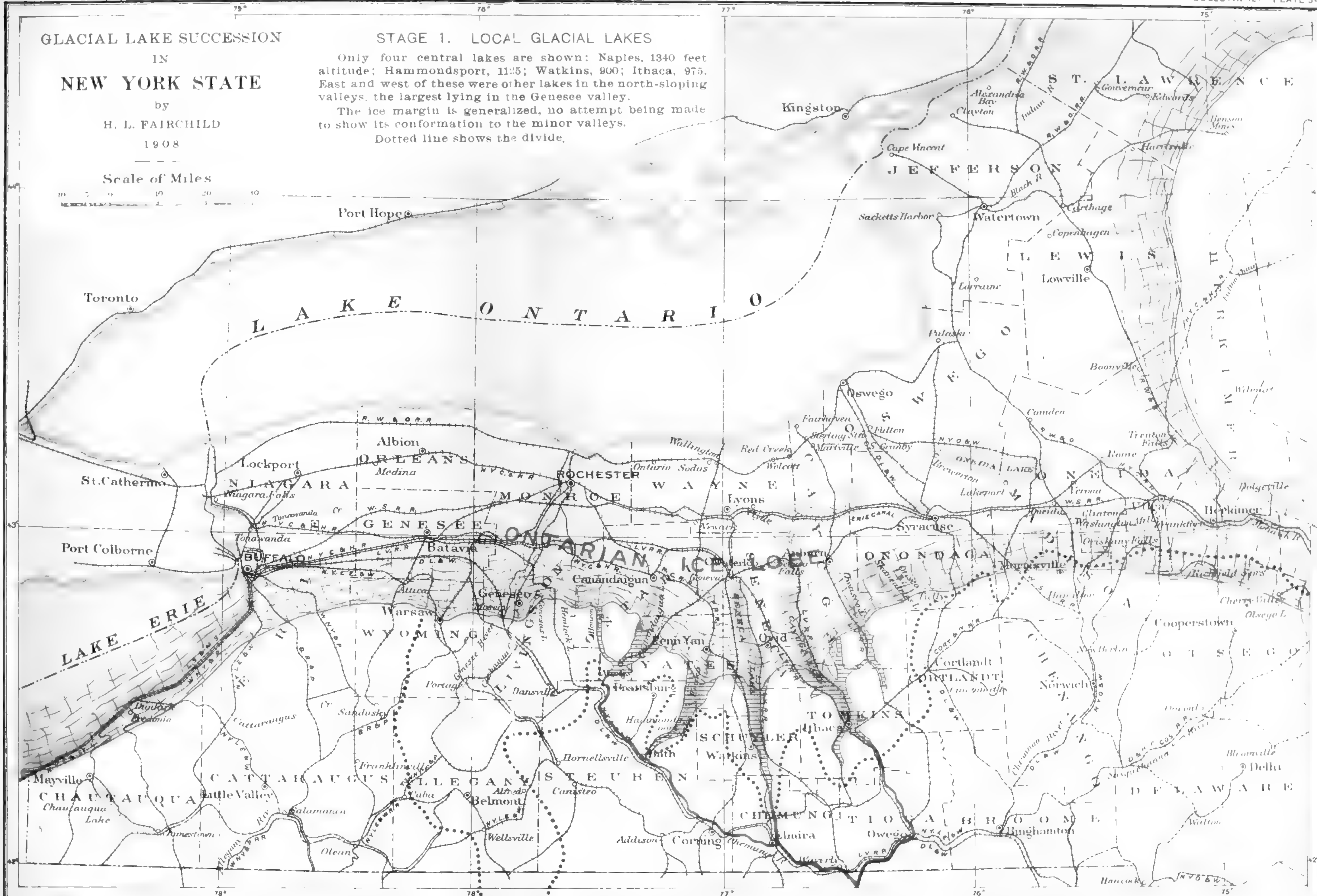
Plates 34-42

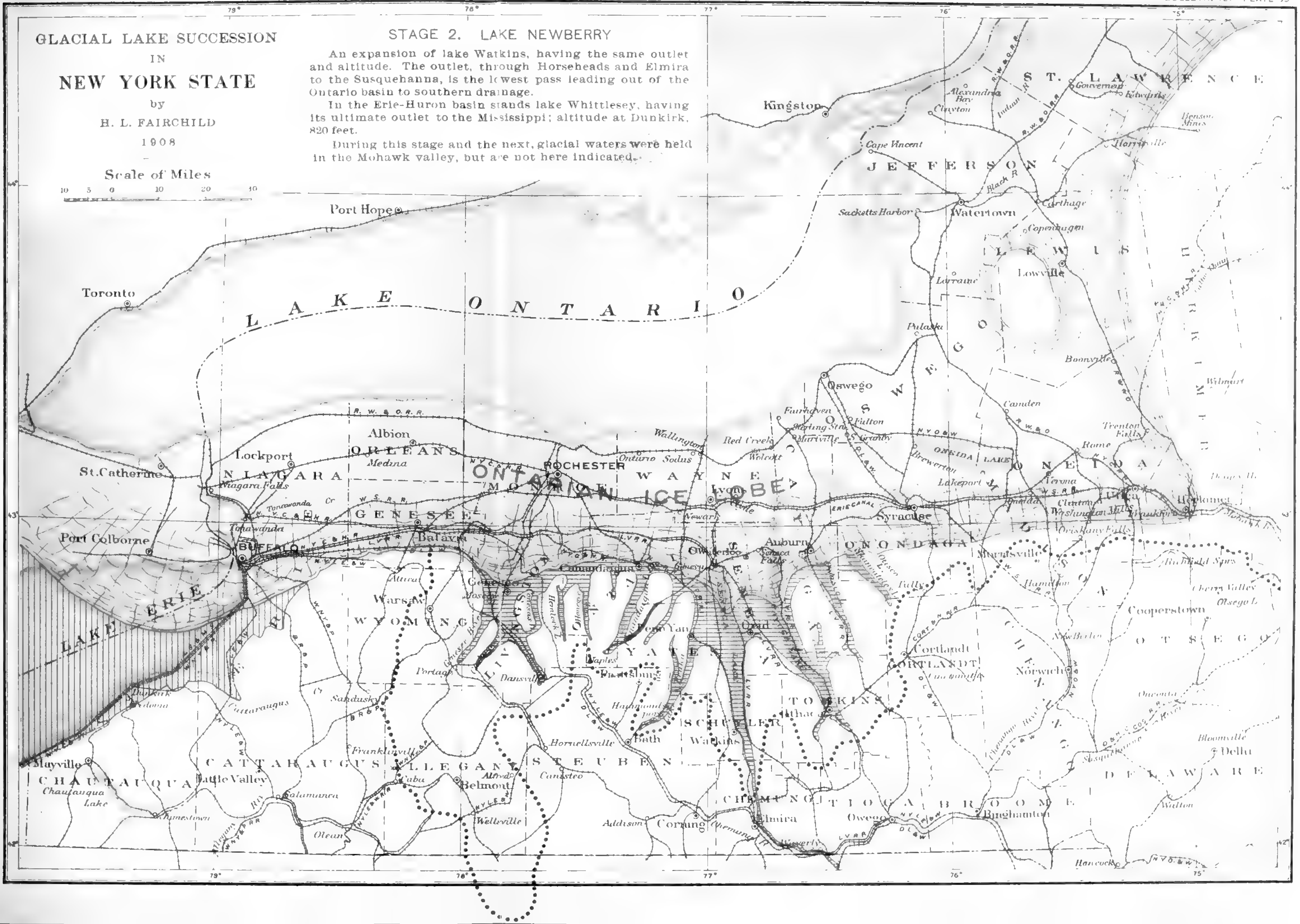
This series of maps shows in a generalized and theoretical way the supposed succession of glacial waters in the central part of the State and graphically epitomizes the history discussed in the paper.

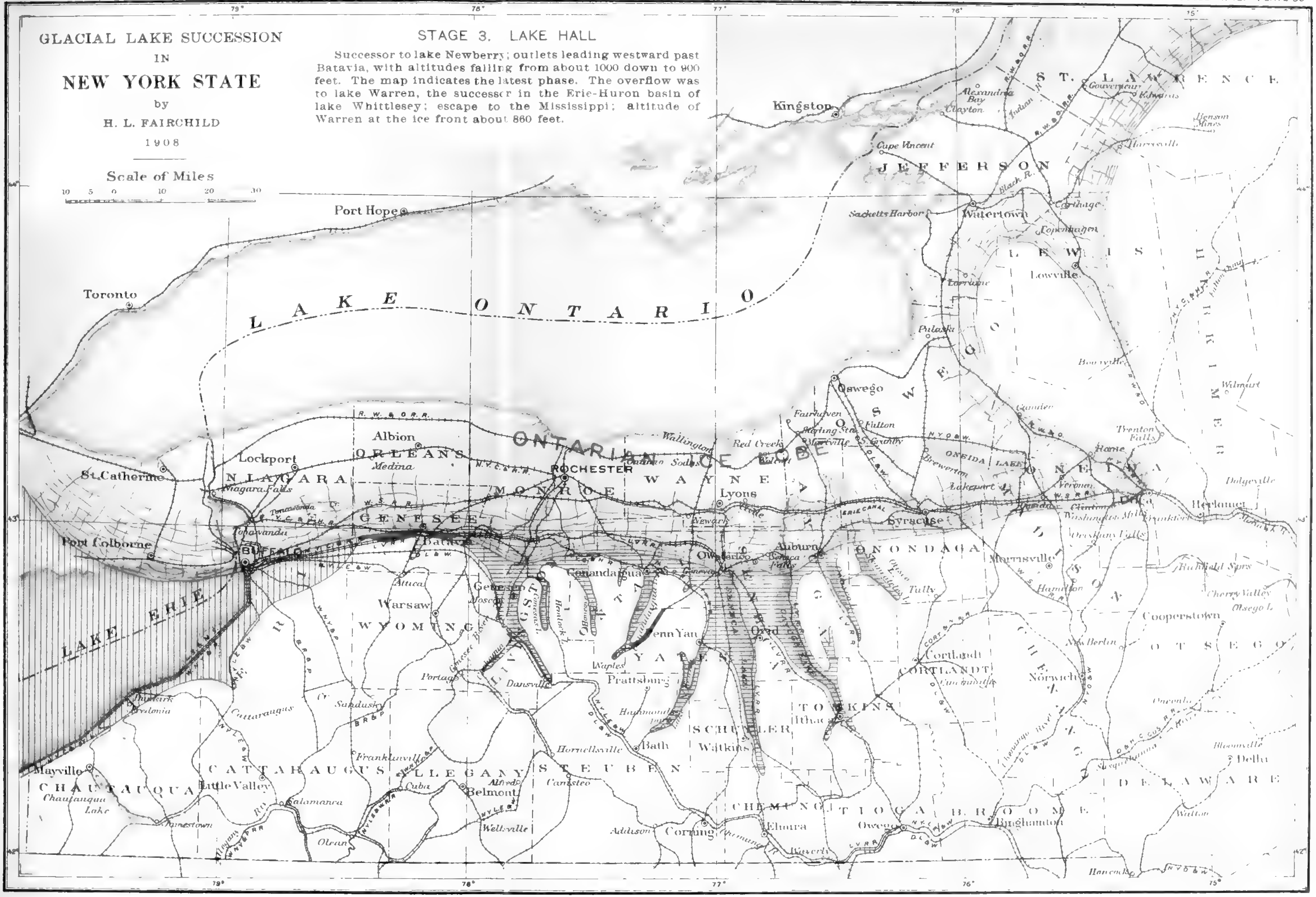
The limitations of the ice sheet are more or less hypothetical, specially in their east and west extensions, or beyond the central territory of Batavia-Syracuse. Some attempt has been made to show the lobations of the ice margin due to the larger valleys but not of the minor sinuosities. It is recognized that the ice border was not always a bold or solid front, but in some districts may have been a thinning sheet, melting to stagnant and separated masses about which the glacial waters circulated.

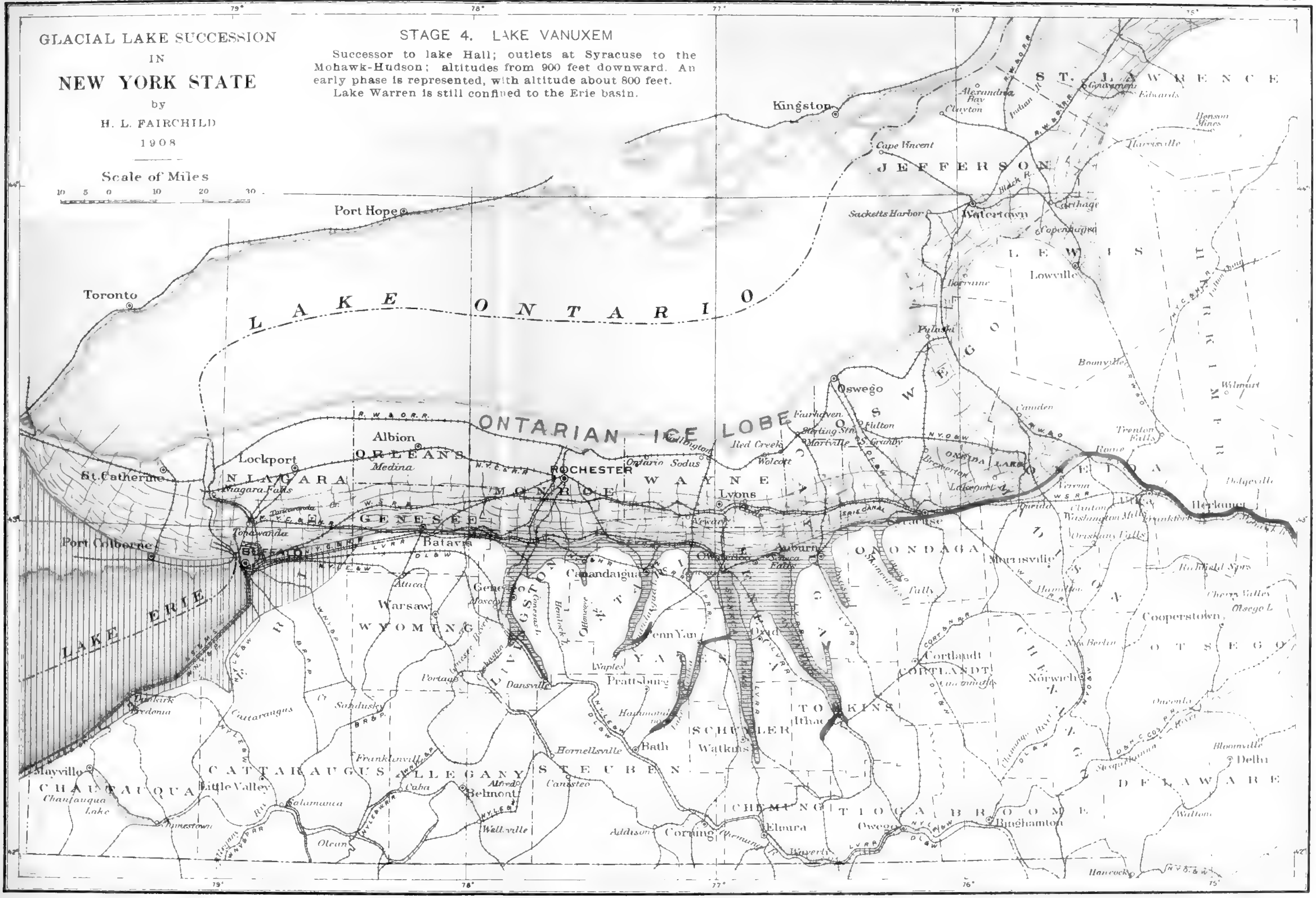
The glacial waters fall into three groups, as distinguished by the color shading. The succession of ice-dammed waters which were indigenous to central New York, the direct inheritance from Lake Watkins, are given horizontal shading. Those waters which originated in the Erie basin are represented by vertical shading; while those which collected in the Oneida-Rome district are expressed by oblique shading.

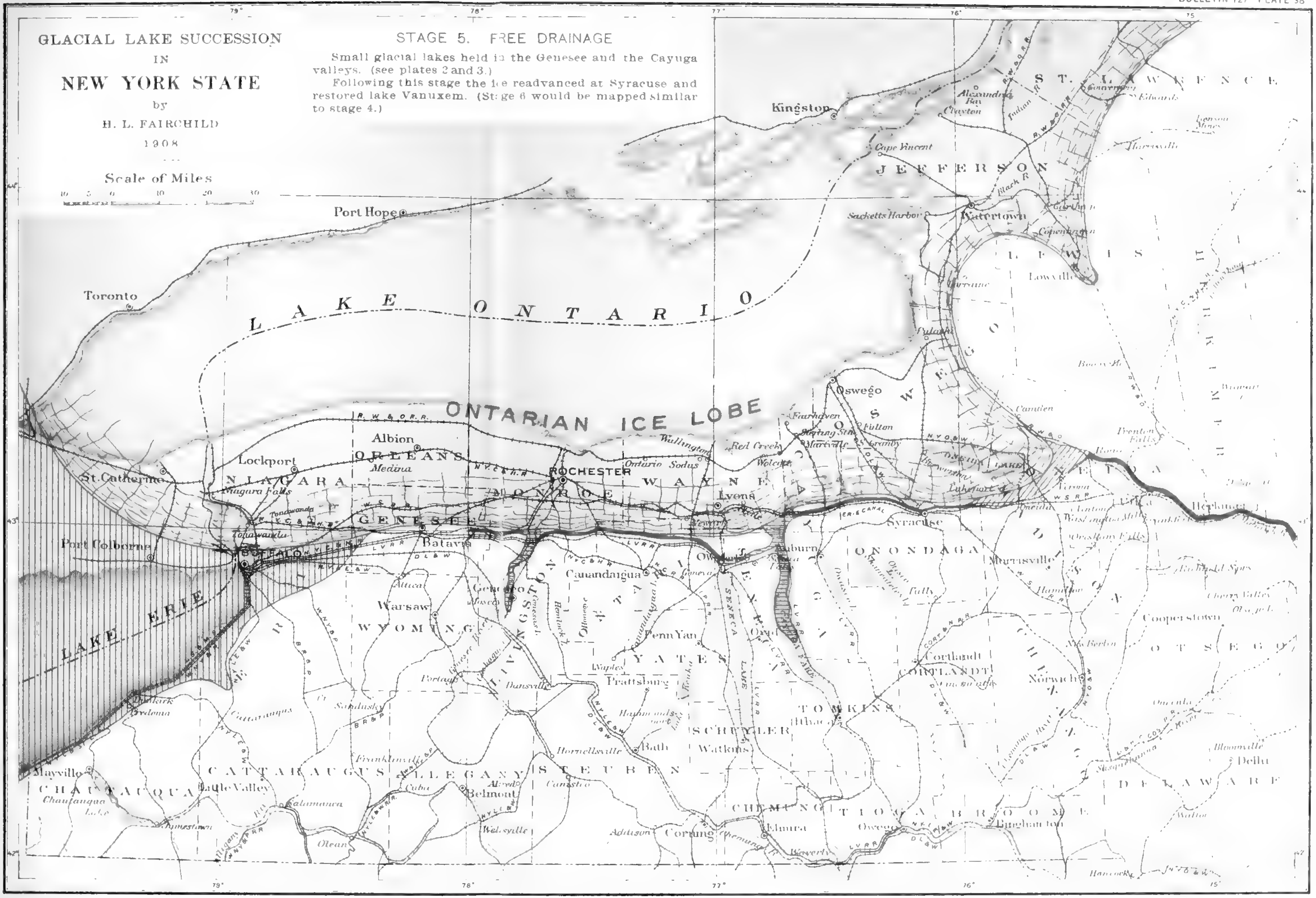
[1] A statement and tabulation of the episodes in the glacial lake history as affecting the Cayuga valley was printed in connection with the preliminary announcement of the special summer meeting of the American Association for the Advancement of Science held at Ithaca, N. Y., June 28–July 3, 1906.

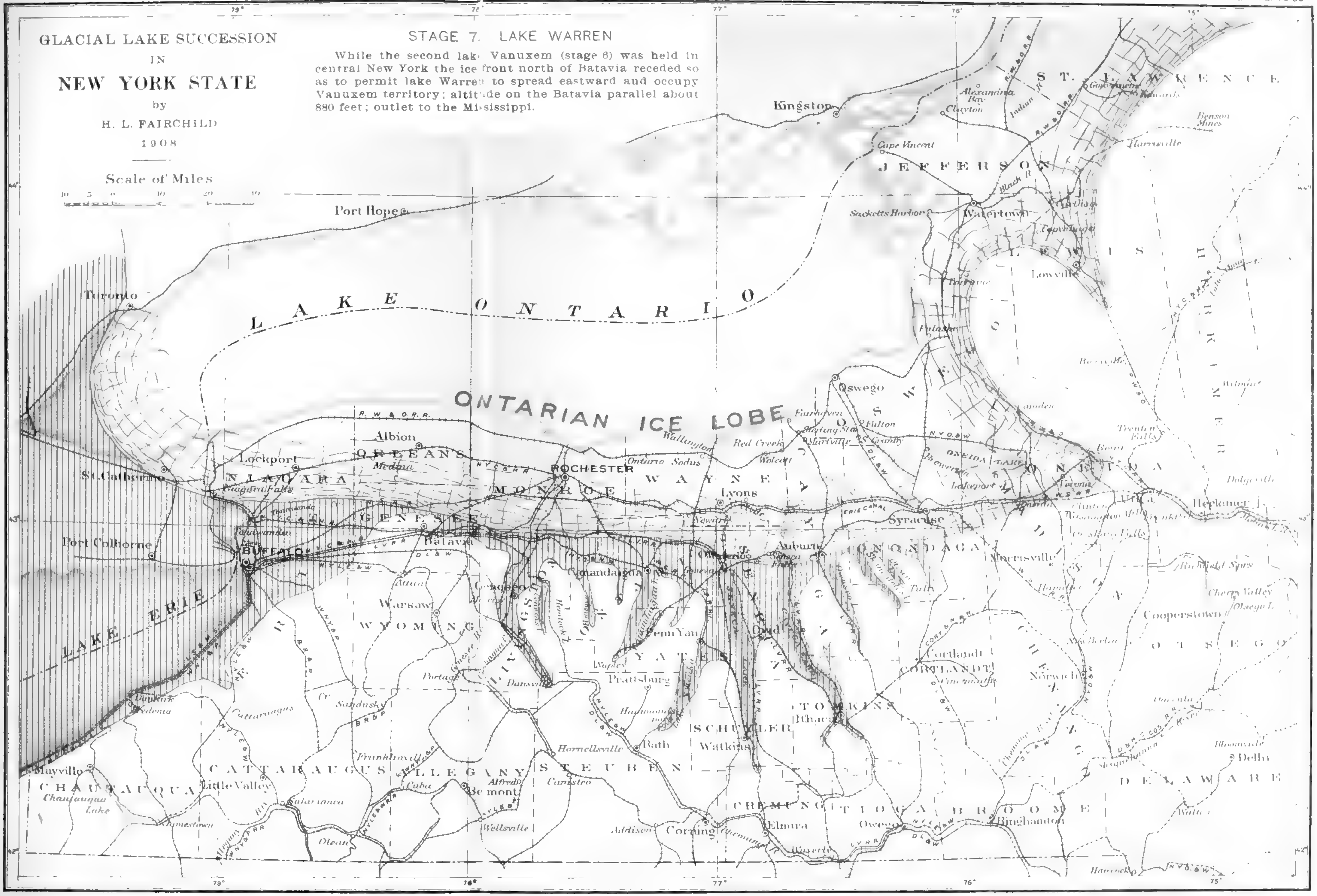

GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
STAGE 1. LOCAL GLACIAL LAKES
Only four central lakes are shown: Naples, 1340 feet altitude; Hammondsport, 1125; Watkins, 900; Ithaca, 975. East and west of these were other lakes in the north-sloping valleys, the largest lying in the Genesee valley.
The ice margin is generalized, no attempt being made to show its conformation to the minor valleys.
Dotted line shows the divide.
LAKE ONTARIO
LAKE ERIE
ONTARIAN ICE LOBE
Toronto
Port Hope
Kingston
St.Catherine
Port Colborne
Lockport
Albion
Medina
ROCHESTER
BUFFALO
Batavia
Warsaw
Geneseo
Canandaigua
Penn Yan
Lyons
Syracuse
Oswego
Watertown
Lowville
Utica
Rome
Herkimer
Cooperstown
Cortlandt
Ithaca
Watkins
Bath
Hornellsville
Corning
Elmira
Owego
Binghamton
Norwich
Delhi
Wellsville
Belmont
Olean
Jamestown
Mayville
Dansville
Ovid
Auburn
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
WYOMING
LIVINGSTON
ONTARIO
YATES
SCHUYLER
STEUBEN
ALLEGANY
CATTARAUGUS
CHAUTAUQUA
CHEMUNG
TIOGA
BROOME
TOMPKINS
CORTLANDT
ONONDAGA
OSWEGO
ONEIDA
JEFFERSON
LEWIS
ST. LAWRENCE
HERKIMER
OTSEGO
DELAWARE
CHENANGO
MADISON
CAYUGA
SENECA

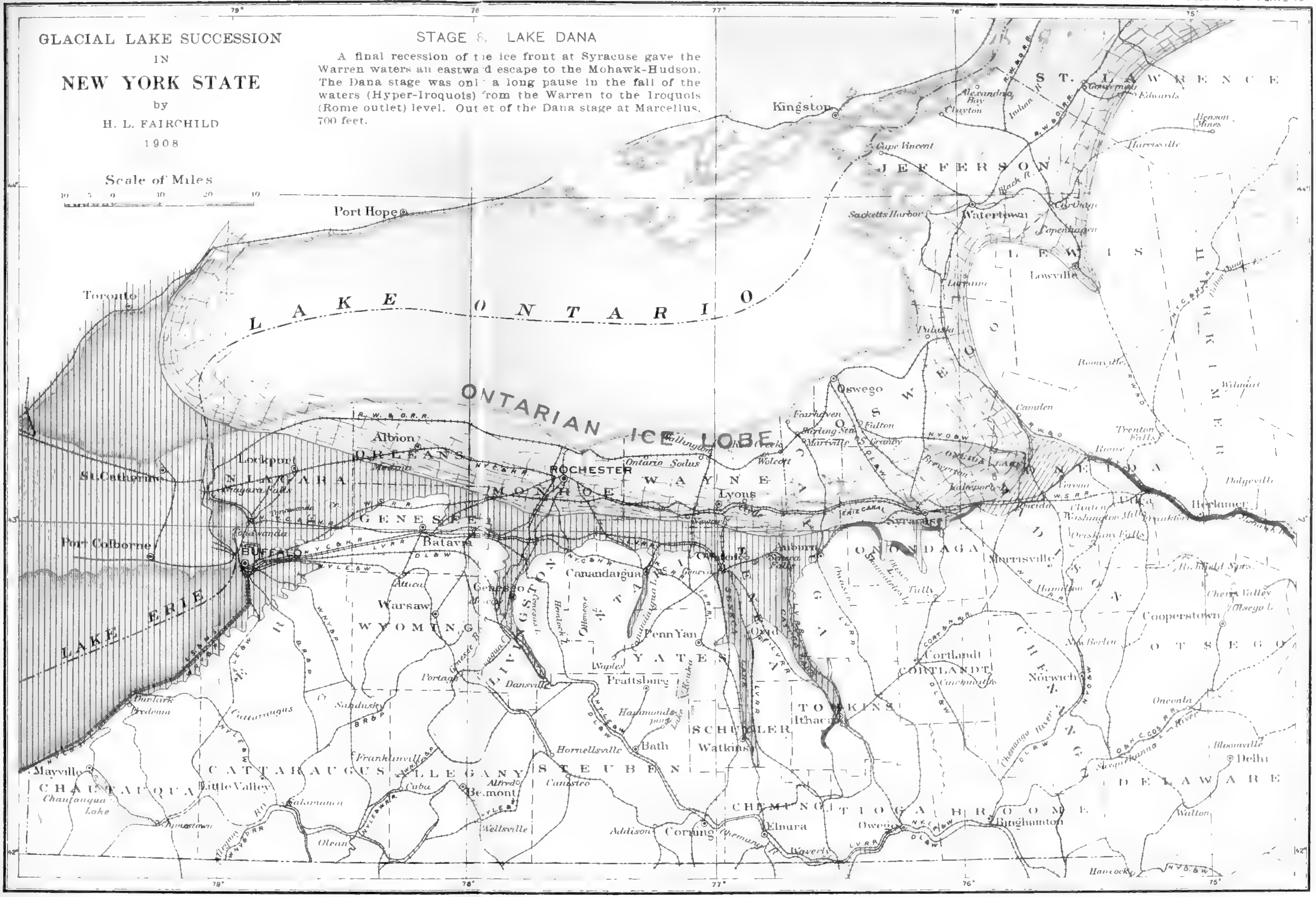

GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
10 5 0 10 20 30
STAGE 2. LAKE NEWBERRY
An expansion of lake Watkins, having the same outlet and altitude. The outlet, through Horseheads and Elmira to the Susquehanna, is the lowest pass leading out of the Ontario basin to southern drainage.
In the Erie-Huron basin stands lake Whittlesey, having its ultimate outlet to the Mississippi; altitude at Dunkirk, 820 feet.
During this stage and the next, glacial waters were held in the Mohawk valley, but are not here indicated.
79°
78°
77°
76°
75°
43°
42°
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
Toronto
Port Hope
Kingston
St.Catherine
Port Colborne
Lockport
Niagara Falls
Tonawanda
BUFFALO
Albion
Medina
ROCHESTER
Batavia
Geneseo
Dansville
Canandaigua
Naples
Geneva
Auburn
Syracuse
Oswego
Watertown
Sacketts Harbor
Cape Vincent
Carthage
Lowville
Pulaski
Rome
Utica
Herkimer
Cooperstown
Cortland
Norwich
Ithaca
Watkins
Bath
Hornellsville
Corning
Elmira
Owego
Binghamton
Olean
Salamanca
Wellsville
Belmont
Dunkirk
Mayville
Jamestown
Hancock
Delhi
NIAGARA
ORLEANS
GENESEE
MONROE
WAYNE
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
ONONDAGA
OSWEGO
JEFFERSON
ST. LAWRENCE
LEWIS
ONEIDA
HERKIMER
MADISON
CHENANGO
OTSEGO
DELAWARE
CORTLAND
TOMPKINS
SCHUYLER
STEUBEN
CHEMUNG
TIOGA
BROOME
ALLEGANY
CATTARAUGUS
CHAUTAUQUA

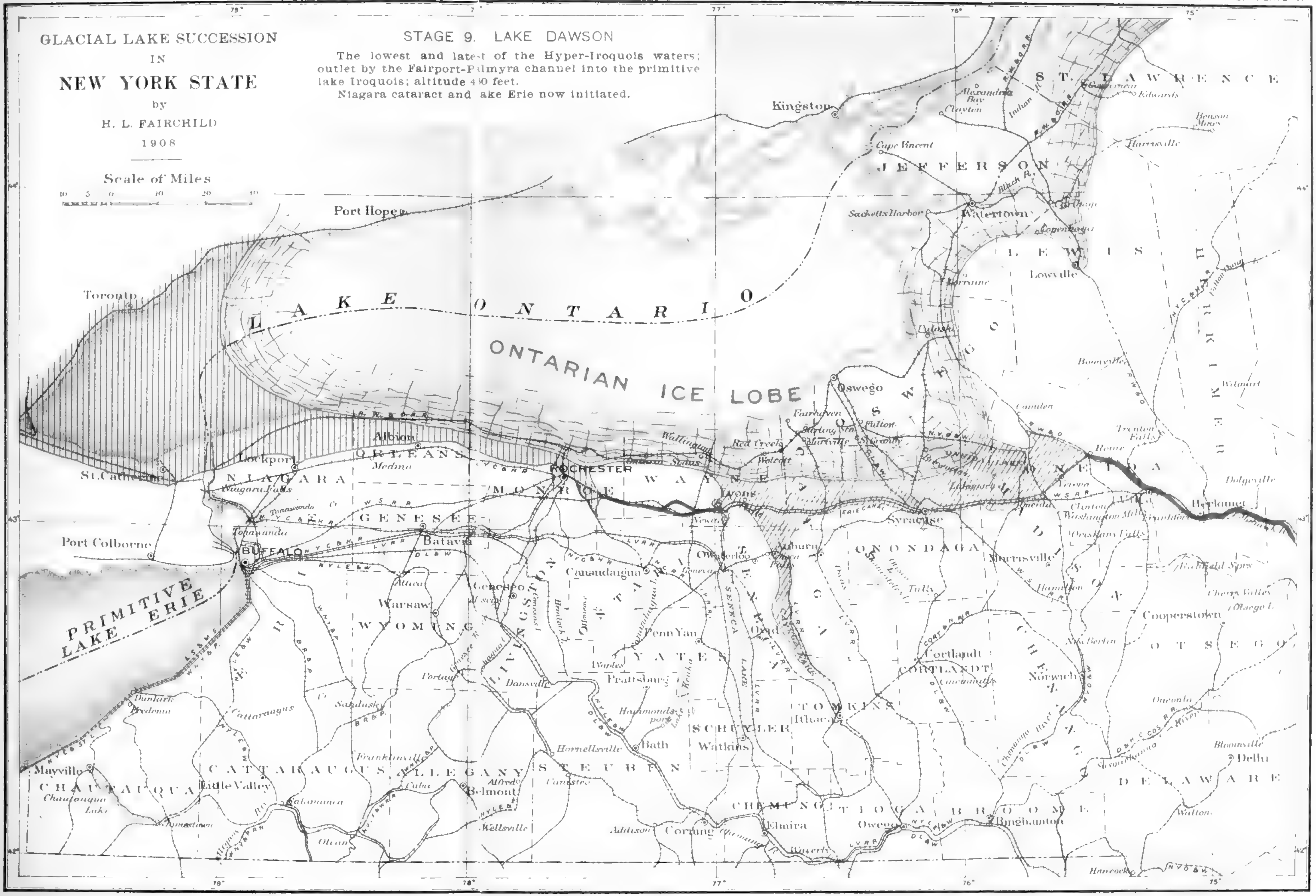

GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
10 5 0 10 20 30
STAGE 3. LAKE HALL
Successor to lake Newberry; outlets leading westward past Batavia, with altitudes falling from about 1000 down to 900 feet. The map indicates the latest phase. The overflow was to lake Warren, the successor in the Erie-Huron basin of lake Whittlesey; escape to the Mississippi; altitude of Warren at the ice front about 860 feet.
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
Toronto
Port Hope
Kingston
St.Catherine
Port Colborne
BUFFALO
Lockport
Albion
ROCHESTER
Batavia
Oswego
Syracuse
Auburn
Watertown
Utica
Ithaca
Elmira
Corning
Binghamton
NIAGARA
ORLEANS
MONROE
GENESEE
WAYNE
ONONDAGA
JEFFERSON
LEWIS
OSWEGO
ONEIDA
MADISON
WYOMING
LIVINGSTON
YATES
SCHUYLER
TOMPKINS
CORTLANDT
CHENANGO
OTSEGO
DELAWARE
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
CHEMUNG
TIOGA
BROOME
ST. LAWRENCE
HERKIMER

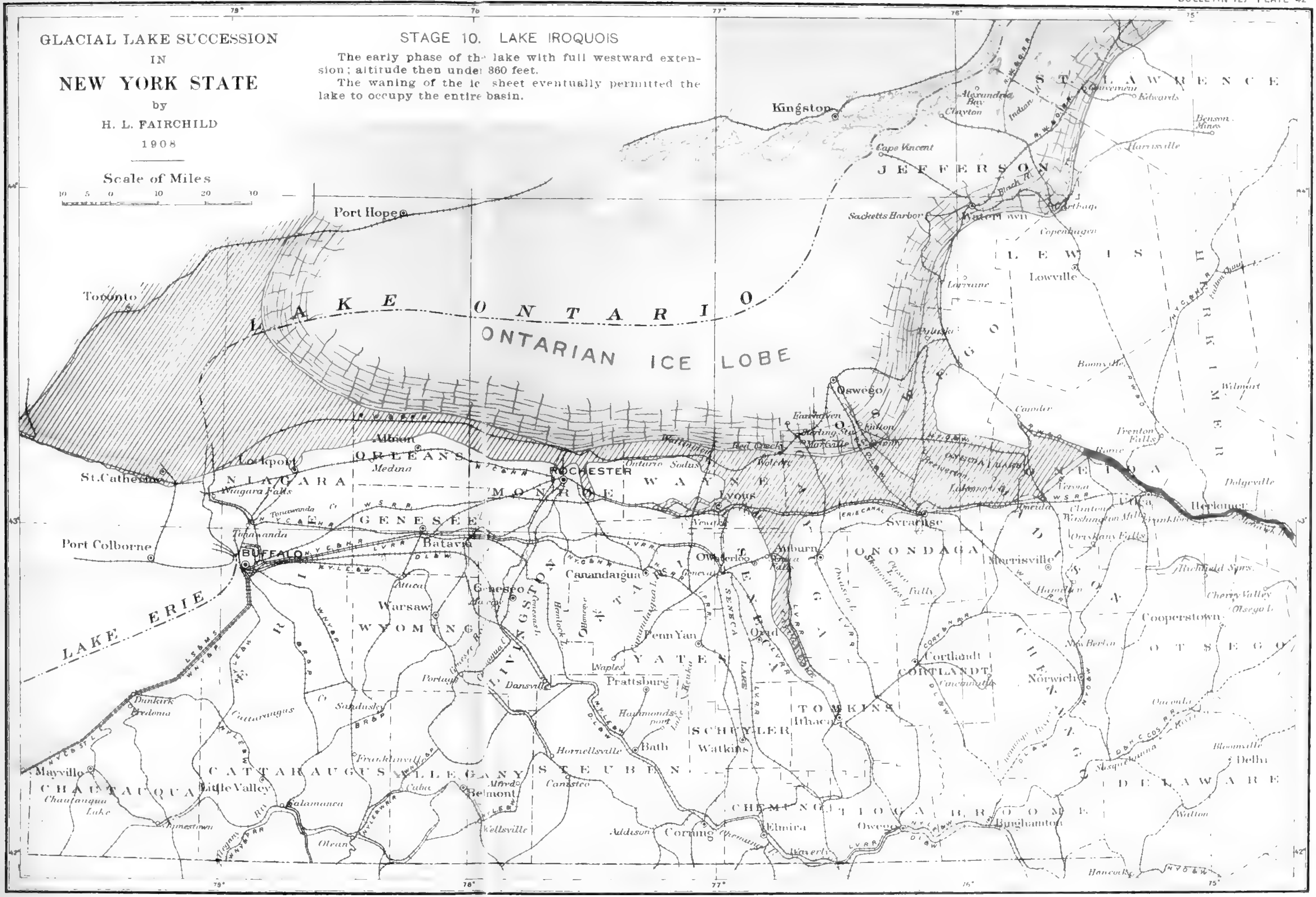

GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
10 5 0 10 20 30
STAGE 4. LAKE VANUXEM
Successor to lake Hall; outlets at Syracuse to the Mohawk-Hudson; altitudes from 900 feet downward. An early phase is represented, with altitude about 800 feet. Lake Warren is still confined to the Erie basin.
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
ST. LAWRENCE
JEFFERSON
LEWIS
OSWEGO
ONONDAGA
CORTLANDT
TOMPKINS
SCHUYLER
STEUBEN
ALLEGANY
CATTARAUGUS
CHAUTAUQUA
WYOMING
GENESEE
NIAGARA
ORLEANS
MONROE
WAYNE
YATES
CHEMUNG
TIOGA
BROOME
DELAWARE
OTSEGO
Kingston
Port Hope
Toronto
St. Catherine
Port Colborne
Lockport
Albion
Medina
ROCHESTER
Batavia
Buffalo
Tonawanda
Niagara Falls
Oswego
Watertown
Lowville
Pulaski
Lyons
Auburn
Syracuse
Canandaigua
Penn Yan
Prattsburg
Bath
Watkins
Ithaca
Cortlandt
Norwich
Cooperstown
Herkimer
Rome
Warsaw
Dansville
Hornellsville
Corning
Elmira
Owego
Binghamton
Belmont
Wellsville
Olean
Salamanca
Little Valley
Mayville
Dunkirk
Jamestown
Delhi
Hancock
Cape Vincent
Sacketts Harbor
Carthage
Clayton
Alexandria Bay
Gouverneur
Boonville
Camden
Fulton
Geneseo
Naples
Waverly
Addison
Canisteo
Walton


GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
10 5 0 10 20 30
STAGE 5. FREE DRAINAGE
Small glacial lakes held in the Genesee and the Cayuga valleys. (see plates 2 and 3.)
Following this stage the ice readvanced at Syracuse and restored lake Vanuxem. (Stage 6 would be mapped similar to stage 4.)
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
Kingston
Port Hope
Toronto
St. Catherine
Port Colborne
Buffalo
Lockport
Albion
Rochester
Batavia
Oswego
Syracuse
Watertown
Auburn
Canandaigua
Geneva
Penn Yan
Ithaca
Elmira
Corning
Bath
Binghamton
Cooperstown
Norwich
Cortland
Herkimer
Dunkirk
Mayville
Warsaw
Belmont
Olean
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
ONONDAGA
OSWEGO
JEFFERSON
LEWIS
ONEIDA
MADISON
CHENANGO
CORTLANDT
TOMPKINS
SCHUYLER
STEUBEN
ALLEGANY
CATTARAUGUS
CHAUTAUQUA
CHEMUNG
TIOGA
BROOME
DELAWARE
OTSEGO
ST. LAWRENCE


GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
STAGE 7. LAKE WARREN
While the second lake Vanuxem (stage 6) was held in central New York the ice front north of Batavia receded so as to permit lake Warren to spread eastward and occupy Vanuxem territory; altitude on the Batavia parallel about 880 feet; outlet to the Mississippi.
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
ST. LAWRENCE
JEFFERSON
LEWIS
OSWEGO
ONEIDA
HERKIMER
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
ONONDAGA
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
CORTLAND
TOMPKINS
SCHUYLER
STEUBEN
CHEMUNG
TIOGA
BROOME
CATTARAUGUS
ALLEGANY
CHAUTAUQUA
OTSEGO
DELAWARE
CHENANGO
MADISON
Kingston
Port Hope
Toronto
St. Catharines
Port Colborne
Lockport
Albion
ROCHESTER
BUFFALO
Batavia
Lyons
Syracuse
Auburn
Oswego
Watertown
Lowville
Utica
Herkimer
Canandaigua
Geneva
Penn Yan
Ithaca
Cortland
Norwich
Cooperstown
Warsaw
Dansville
Prattsburg
Bath
Watkins
Hornellsville
Corning
Elmira
Owego
Binghamton
Delhi
Olean
Little Valley
Mayville
Jamestown
Salamanca
Wellsville
Belmont
Sackets Harbor
Cape Vincent
Clayton
Pulaski
Fulton
Dunkirk
Fredonia
Chautauqua Lake
79°
78°
77°
76°
75°
43°
44°
42°


GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
STAGE 8. LAKE DANA
A final recession of the ice front at Syracuse gave the Warren waters an eastward escape to the Mohawk-Hudson. The Dana stage was only a long pause in the fall of the waters (Hyper-Iroquois) from the Warren to the Iroquois (Rome outlet) level. Outlet of the Dana stage at Marcellus, 700 feet.
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
Kingston
Port Hope
Toronto
St. Catharines
Port Colborne
Buffalo
Lockport
Albion
Rochester
Batavia
Lyons
Oswego
Syracuse
Watertown
Lowville
Utica
Herkimer
Auburn
Geneva
Canandaigua
Penn Yan
Warsaw
Geneseo
Dansville
Ithaca
Watkins
Bath
Hornellsville
Corning
Elmira
Owego
Binghamton
Cortland
Norwich
Cooperstown
Delhi
Oneonta
Mayville
Jamestown
Salamanca
Olean
Belmont
Little Valley
JEFFERSON
LEWIS
OSWEGO
ONEIDA
HERKIMER
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
ONONDAGA
MADISON
CORTLAND
CHENANGO
OTSEGO
DELAWARE
BROOME
TIOGA
CHEMUNG
SCHUYLER
TOMPKINS
STEUBEN
ALLEGANY
CATTARAUGUS
CHAUTAUQUA
ST. LAWRENCE
ERIE CANAL
79°
78°
77°
76°
75°


GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
STAGE 9. LAKE DAWSON
The lowest and latest of the Hyper-Iroquois waters; outlet by the Fairport-Palmyra channel into the primitive lake Iroquois; altitude 450 feet.
Niagara cataract and lake Erie now initiated.
LAKE ONTARIO
ONTARIAN ICE LOBE
PRIMITIVE LAKE ERIE
Kingston
Port Hope
Toronto
St.Catharines
Port Colborne
BUFFALO
ROCHESTER
Syracuse
Oswego
Watertown
Lockport
Albion
Batavia
Canandaigua
Penn Yan
Ithaca
Elmira
Corning
Binghamton
Cortlandt
Auburn
Geneva
Lyons
Bath
Watkins
Norwich
Cooperstown
Herkimer
Mayville
Olean
Belmont
Warsaw
Geneseo
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
ONONDAGA
OSWEGO
JEFFERSON
LEWIS
ST. LAWRENCE
HERKIMER
ONEIDA
MADISON
CHENANGO
CORTLANDT
TOMPKINS
SCHUYLER
STEUBEN
CHEMUNG
TIOGA
BROOME
DELAWARE
OTSEGO
ALLEGANY
CATTARAUGUS
CHAUTAUQUA


GLACIAL LAKE SUCCESSION
IN
NEW YORK STATE
by
H. L. FAIRCHILD
1908
Scale of Miles
STAGE 10. LAKE IROQUOIS
The early phase of the lake with full westward extension; altitude then under 360 feet.
The waning of the ice sheet eventually permitted the lake to occupy the entire basin.
LAKE ONTARIO
ONTARIAN ICE LOBE
LAKE ERIE
Kingston
Port Hope
Toronto
St.Catherine
Port Colborne
Lockport
Albion
ROCHESTER
BUFFALO
Batavia
Oswego
Syracuse
Watertown
Sacketts Harbor
Cape Vincent
Lowville
Utica
Herkimer
Auburn
Canandaigua
Geneseo
Warsaw
Penn Yan
Ithaca
Cortland
Norwich
Cooperstown
Elmira
Corning
Bath
Binghamton
Salamanca
Belmont
Mayville
Little Valley
J E F F E R S O N
S T. L A W R E N C E
L E W I S
N I A G A R A
O R L E A N S
M O N R O E
G E N E S E E
W A Y N E
O N O N D A G A
W Y O M I N G
Y A T E S
S C H U Y L E R
T O M K I N S
C O R T L A N D
S T E U B E N
C H E M U N G
T I O G A
B R O O M E
D E L A W A R E
O T S E G O
C A T T A R A U G U S
A L L E G A N Y
C H A U T A U Q U A

The areas of the lake waters are indicated in only a general way, it being impossible in such small maps to show minor features. A special difficulty in mapping the ancient shore lines is due to the land warping. The northward uptilting of the Ontario basin was probably in progress during the time of the waning of the ice sheet and has continued down to the present. This progressive uplift makes it impossible to closely assign the proportionate deformation for the individual lakes. The slant of the Newberry plane is estimated at about 2 feet per mile on the average, and the lake areas are here mapped on that basis; the Newberry plane rising from about 900 feet at Horseheads (the channel bottom) to about 1000 feet toward the Batavia parallel.

The matter of the glacial water levels is further complicated by some east and west deformation. We have as yet no clear measure of the warping in that direction previous to Iroquois time, though the Warren beaches indicate that it was not large. The long west to east stretch of the south shore of Iroquois and its mature character give us a fair measure of the post-Iroquois deformation. Altitudes on the Iroquois shore are as follows: Hamilton, Ont., 362 feet above tide; Lewiston, 383; Lockport, 402; Gaines, 430; Sodus, 456; Rome, 460. From Hamilton to Sodus is about 138 miles, with equal latitude, and the rise of the water plane is 0.68 feet per mile, or something over 8 inches. From Sodus to Rome, in direction only slightly south of east, and the distance about 82 miles, the deformation is practically nothing. It is apparent that since Lake Iroquois was drained away the Sodus-Rome district has been lifted about 100 feet more than the west end of the basin.

To restore the geographic conditions that existed during the ice retreat we must depress the Rome end of the basin about 100 feet. This fact, coupled with the low channels in the Syracuse district prove that in pre-Iroquois time there was free drainage to the Mohawk valley, as shown in stage 5 [pl. 38]. The col at Rome is partly due to differential uplift and partly to delta filling by the upper Mohawk river in the glacial waters held in the Mohawk valley.

The altitude figures given in the descriptive legends on the maps refer to the present altitudes.

SUMMARY OF THE GLACIAL DRAINAGE HISTORY

1 All the glacial waters of the Lake Erie basin down to and including Lake Warren escaped westward to the Mississippi.

The lowering Warren and all subsequent waters flowed eastward to the Mohawk-Hudson.

2 The pre-Warren waters in central New York had a complicated history with varying levels and different outlets. These waters fall into two provinces; those tributary to the Seneca valley, the glacial Lake Newberry [pl. 35], with southward escape at 900 feet through Horseheads to the Chemung-Susquehanna; and those tributary to the Genesee valley. The higher waters of the latter area oscillated between escape to the Allegany-Mississippi and to the Susquehanna, but under 1200 feet and down to about 900 feet, the altitude of the scourways at Batavia, the Genesee waters escaped westward to the Warren lake. Between the now tilted plane of Lake Newberry, about 1000 feet on the Batavia parallel, and 900 feet, the Batavia scourways, all the waters of the Seneca basin area as well as the Genesee area poured westward into Lake Warren.

3 The west-flowing waters with outlets on the Batavia meridian across to Lake Warren, from about 1200 feet, have been called in a former writing the Seventh Stage, or Warren Tributary Stage of the Genesee glacial lakes. It is now proposed to differentiate the waters standing between the Newberry plane, about 1000 feet at Batavia, and the plane represented by the 900 feet scourways at Batavia and give it a distinctive name, for the reason that it was the immediate successor of Lake Newberry and had a broad relationship, covering the provinces of both the Seneca and Genesee basins and extended eastward to the neighborhood of Syracuse. The name is Lake Hall, after James Hall, whose district under the early survey of the State included the western end of the State and much of the territory covered by these waters.

4 Lake Hall received as tributary drainage all the glacial waters and the land streams of the central New York valleys as far east as the Onondaga valley, and probably as far as to the Limestone and Cazenovia valleys, or to the village of Jamesville. It formed a narrow stretch of east and west water but with southward prolongations extending up the several deep valleys [pl. 36].

5 During the life of Lake Hall the ice barrier in the Syracuse district was a dam somewhat higher than that on the Batavia meridian. Possibly there were oscillations with temporary flow in either direction. But certainly there came a time when the ice front receded at Syracuse so as to uncover passes below 900 feet altitude, and then the central New York waters (Lake Hall) found

steady eastward escape to the Mohawk-Hudson, which had been cleared of its ice barrier. The waters with eastward flow, and under 900 feet, are here named Lake Vanuxem, after Lardner Vanuxem, a coworker with Hall and whose district included the Syracuse region [pl. 37].

6 The outlet channels of the Vanuxem waters lie on the north-facing slopes west of Syracuse, on Howlet hill and at Split Rock, while the channels of continued flow lie across the ridges east of Syracuse [pl. 4].

7 Continued recession of the ice front in the Syracuse district finally lowered Lake Vanuxem until it was represented only by the shallow waters over the Seneca-Cayuga depression (the Montezuma marshes area) and a separate narrow lake in the Genesee valley [pl. 38]. The series of east-leading channels which head east and north of Leroy and extend to Phelps were made by the ice-border or proglacial drainage during the lowering and extinction of Lake Vanuxem.

8 During the life and extinguishment of Lake Vanuxem the Warren waters were excluded from central New York and confined to the Erie basin by the ice barrier north of Batavia.

Subsequent to the extinction of Lake Vanuxem, the length of time unknown, the ice front readvanced in the Syracuse district with a consequent redamming of the central New York waters. The result was the re-creation of Lake Vanuxem (in rising levels) and possibly the renewal of Lake Hall.

9 While Lake Vanuxem II (or perhaps a Lake Hall II) was in existence the ice front receded from the scarp north of Batavia and Lake Warren extended its domain into central New York. The reason for postulating a second Lake Vanuxem or even a second Lake Hall is the absence of great channels across the salient north of Batavia, which would surely occur if Lake Warren had found central New York an unoccupied basin. The lack of channels phenomena in the Oakfield district is explained by assuming an approximation of level between the Warren and the central New York waters, along with the probability of an area of stagnant ice in the locality where the waters met [pl. 39].

10 The Warren waters immersed the channel features produced by the extinction of the first Lake Vanuxem, and its records, specially of the lowering level (Lake Dana) are found northward of the Leroy-Victor-Phelps channel. The Warren water, at about 880 feet, endured in central New York long enough to produce some frag-

mentary but positive beaches, deltas and weak erosion planes [pl. 33]. Then it was itself extinguished by another waning of the ice barrier in the region of Syracuse.

11 The singular and apparently contradictory relation in altitude of the stream channels southwest of Syracuse may be explained by supposing that the Marcellus-Cedarvale valley was blocked by entrapped ice (probably drift-buried) during the time when the Vanuxem waters existed but that the subsequent melting of the ice opened the pass for sub-Warren flow at an altitude inferior to the Vanuxem outflow. The great channels and cataracts southwest and southeast of Syracuse with altitudes under the Warren plane received at least their final expression by its outflow and down draining.

12 The sub-Warren (or hyper-Iroquois) waters must have lowered somewhat spasmodically, that is, rapidly as new outlets were suddenly found and slowly as the longer-lived outlets were being excavated. Only one decided pause has been registered in discovered beaches, that of Lake Dana, 700 feet [pl. 40]. The only strong channel that can be correlated in altitude with the Dana plane is the Marcellus-Cedarvale channel. To make this effective requires the assumption that the ice barrier lay northeastward so as to leave the north and south Marcellus (Ninemile creek) valley open.

13 The well developed river channel leading east from Fairport to Lyons [pl. 3] apparently represents an episode of proglacial drainage distinct from that which produced the Victor-Phelps channel series. It is supposed that this northern channel was cut or at least given its present form by proglacial river flow during a sub-Dana or hyper-Iroquois stage. Apparently it is the lowest and latest channel cut by glacial stream flow in western New York, correlating with the low passes through Syracuse. The hypothetical lake which overflowed by the Fairport channel extended westward from the Rochester district, with altitude only 30 or 40 feet higher than its successor, Lake Iroquois. This lake is named Lake Dawson, after Dr George M. Dawson [pl. 41].

14 Niagara falls and Lake Erie came into existence while the falling hyper-Iroquois waters were recutting the lower channels, under 600 feet, at Syracuse, and later the channel leading east from Fairport, near Rochester. The emergence of the Niagara escarpment at Lockport and Lewiston above the lowering waters produced a barrier which confined the western waters to the Erie basin [*see* p. 30].

15 Succeeding the Dana and Dawson episodes the next long-permanent water level in the Ontario basin is that of Lake Iroquois. Its level was determined by the pass at Rome leading over to the Mohawk valley. About Syracuse the Iroquois shore-line features have an altitude of 430 to 440 feet; but are about 460 feet near Rome [pl. 42].

Conclusion. It does not seem possible that the history of the glacial waters in central New York can be any more simple than given in the above outline. On the contrary it is probable that future and more detailed study will discover new elements in the glacial history and find the series of events more complicated. It is therefore possible that some of the above theory may be wrong. However, there is no doubt of the existence of the several planes of glacial waters as discriminated above, nor of the production of the channels by ice border rivers. These facts of observation will stand even if the interpretation may change.

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Appendix 2

Paleontology

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128 Geology of the Geneva-Ovid Quadrangles

Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 445 ALBANY, N. Y. April 15, 1909

New York State Museum

John M. Clarke, Director

Museum bulletin 128

GEOLOGY OF THE GENEVA-OVID QUADRANGLES

BY

D. DANA LUTHER

New York State Education Department
Science Division, November 20, 1908

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, a report on the geology of the Geneva and Ovid quadrangles, accompanied by a map on the scale of one mile to the inch.

Very respectfully yours

JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 21st day of November 1908

A. S. Draper

Commissioner of Education

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BY

D. DANA LUTHER

The geologic map of the Geneva and Ovid quadrangles covers an area of 455 square miles in the heart of the Finger Lakes region of central New York.

A part of this area embracing about 100 square miles lying to the north of Seneca lake and Seneca river is a low, flat, alluvial region diversified with many kames and drumlins, conical or oblong hills of sand and gravel that rarely reach a hight of more than 100 feet and are usually much lower.

In this region the soft red Vernon and gray Camillus shales that succeed the Medina sandstones and Lockport dolomites at the north were excavated during the glacial epoch to considerably greater depth than those harder rocks, thereby producing a broad shallow depression that extends eastward from Ontario county to Onondaga county, and through which the waters from a large part of the Finger Lakes drainage area reach Lake Ontario by way of the Seneca and Oswego rivers. The northern part of the Geneva quadrangle lies in this depression and although possessing features of extraordinary interest to the student of glacial geology is wholly devoid of rock outcrops by which the contact lines of the geologic subdivisions can be located. The area lying south of the Seneca river, however, presents entirely different characteristics as it lies on the sloping northern edge of the great New York plateau against which the ice sheet here spent a large part of its erosive force in deepening and enlarging the old preglacial depressions, now the Seneca lake and Cayuga lake valleys, to their present depth and size, leaving a broad separating ridge between them.

This ridge, barely above the present lake level at the north end, rises toward the south at an average rate of 50 feet per mile to 1400 feet above it at the south side of the Ovid quadrangle.

The higher eastern and western slopes are moderately steep, ranging from 100 to 250 feet per mile, while the lower reach 400 to 500 feet per mile and nearly vertical cliffs extend for many miles along the lake shores, in which there is a magnificent display of the stratigraphy of the region; the numerous ravines and gorges cut through the thin drift mantle that overspreads the ridge, some of which show rock walls 100 to 200 feet in hight, afford abundant opportunities for the collection of fossils. These conditions have made this region a specially attractive one to geologists and its stratigraphy and surface phenomena have been discussed by several scientific writers among whom are Prof. James Hall in the annual and final reports of the fourth geological district 1837 to 1842, and Dr D. F. Lincoln in a report on the geology of Seneca county published in the 14th Report of the State Geologist of New York, 1895.

STRATIGRAPHY

The following formations are represented on the map:

Devonic....	Chautauquan	Chemung sandstone
		Prattsburg shale
	Senecan.....	High Point sandstone
		West Hill flags and shale
		Grimes sandstone
		Hatch shale and flags
		Rhinestreet shale
		Cashaqua shale
		West River shale
		Genundewa limestone horizon
		Genesee shale
		Tully limestone
	Erian.......	Moscow shale
		Tichenor limestone
		Ludlowville shale
		Skaneateles shale
		Cardiff shale
		Marcellus shale
	Ulsterian....	Onondaga limestone
	Oriskanian..	Oriskany sandstone

Ontaric or Siluric....	Cayugan....	Manlius limestone Rondout waterlime Cobleskill waterlime Bertie waterlime Camillus shale

The strata composing the surface rocks of these quadrangles as delineated on the map have an aggregate thickness of 2140 feet of which 1460 feet are exposed by the gradual elevation of the land from 400 feet A. T. in the northeast corner of the Geneva quadrangle to 1860 feet A. T. near the southeast corner of the Ovid quadrangle and 680 feet are brought up by the elevation of the strata toward the north and east at an average rate of 24 feet per mile.

It is proper to call attention to the fact that variations in the thickness of the strata and the undulatory condition of the bedding make calculations of the dip of little value except as between any two specified points.

SILURIC

Camillus shale

The lowest and most northern of the rock series exposed on the Geneva quadrangle is the Camillus shale, a small outcrop showing 8 feet of the platten dolomites of the lower part of this formation occurring on Black creek 1 mile south of Tyre.

This is the only rock exposure on these quadrangles north of the Auburn branch of the New York Central Railroad, all of that region having a mantle of drift varying from a few feet in the lower swampy plains to 100 feet or more in the numerous drumlins and kames that diversify the landscape. Therefore the coloring is to be taken as showing the surface area of the rock formations in a plane having a presumed elevation of about 400 feet A. T.

The Camillus shale is that subdivision of the Salina group that succeeds the Vernon red shale and is composed in the lower part of thin dolomitic limestones and thin layers of soft shale and at the top has a bed of gypseous shale 35 feet thick, some parts of which are of sufficient purety to have, when pulverized, some economic value as land plaster and wall plaster. Gypsum was quarried about 1840 near Black brook west of Nichols Corners and the bed has been penetrated in the bottom of wells in that vicinity. It is not exposed along that stream now, the exposure south of Tyre being below it. It is well displayed, however, in the cliff along the north

side of the Seneca river for a mile east of Seneca Falls, and in several places on the south side in cliffs and old quarries. More than 5000 tons were quarried annually in this immediate vicinity in the middle of the last century.

This stratum is exposed in a line of quarries and natural outcrops extending from Madison county to Genesee county showing a variable proportion of gypsum in the clay shales at different localities.

The first discovery of gypsum in the United States is said to have been made in the year 1792 at Camillus, N. Y. where the bed is extensively exposed; hence the formation name.

Traces of organic life are absent from the Camillus shale except for the rare appearance of the little ostracod, Leperditia alta (Conrad), and obscure markings that are perhaps trails made by this or a similar organism.

Bertie waterlime

This is a mass of impure magnesian limestone, hard and dark when freshly broken, but softening and changing to a light ashen gray or buff color when exposed.

It is usually in layers 3 inches to 10 inches in thickness, separated by thin partings of carbonaceous matter. Some of the layers are quite compact and in these the rock has a conchoidal fracture; others are thinly laminated and weather into a hard slaty shale.

The "cement rock" so extensively quarried in Erie county is in the upper part of this formation and some of the layers have been burned and used as waterlime all along its line of outcrops in the central and western part of the State. In this vicinity it has fallen into disuse for that purpose, probably because it has been found lacking in the proportion of silicon necessary to good cement.

The Bertie waterlime is well exposed in the rock wall on the south side of the river at Seneca Falls below the bridge and the contact with the Camillus shale at the base may be seen in the banks for half a mile eastward. As the upper contact is covered, the thickness can only be estimated, but it is approximately 22 feet. Fossils are rare in these beds but the few that do occur are exceedingly interesting as the fauna is a peculiar association of crustaceans, the remains of which while few and fragmentary in this vicinity, are more common at Buffalo and in Herkimer county and have made this horizon one of the most interesting of the New York series.

At Buffalo there have been collected from the Bertie limestone, the ostracod Leperditia scalaris Jones, Ceratiocaris accuminata Hall and an extensive eurypterid fauna. A few lingulas, Orbiculoidea and other brachiopods occur in the lower layers at Union Springs.

Cobleskill waterlime

In this locality this formation is composed of three or four layers of hard, dark limestone that after long exposure weathers to a dark brown.

It is exposed on the Geneva quadrangle only in the old McQuan quarry a mile southwest of Seneca Falls, where the upper layer, a compact coralline stratum 7 feet thick, and 1 foot of similar rock below without coral, yet remains uncovered.

The lower part not being exposed the actual thickness of the formation here is not known but on Frontenac island at Union Springs it is 8 feet, 6 inches thick and as it increases slowly toward the west 10 to 12 feet is a fair estimate of its thickness in this quarry.

In the western part of the State where the Cobleskill is known to quarrymen as "bullhead" it is lighter colored, scraggy and contains many small cavaties produced by the weathering out of small fossils and crystals of calcite.

It is everywhere quite fossiliferous. The heavy layer in the McQuan quarry is largely composed of the coral, Stromatopora concentrica Hall and on Frontenac island where the exposure is specially favorable for collecting and where fossils are more than commonly abundant, 30 species have been found to occur. Of these, the more common forms next to the Stromatopora are:

Favosites niagarensis? *Hall*
Halysites catenulatus *Linné*
Cyathophyllum hydraulicum *Simpson*
Spirifer crispus *var.* corallinensis *Grabau*
Stropheodonta varistriata *Conrad*
Whitfieldella sulcata (*Vanuxem*)
Ilionia sinuata *Hall*
Trochoceras gebhardi *Hall*
Leperditia alta (*Conrad*)

Rondout waterlime

Overlying the Stromatopora layer in the McQuan quarry there is a bed of dark somewhat shaly magnesian limestone 9 feet thick, some parts of which are dolomitic. It is the only exposure on this quadrangle of the Rondout waterlime, a formation 40 feet thick in

the eastern part of the State, that by decrease in the amount of sediment or by transition in character, thins out in a westerly direction and is not known beyond Livingston county.

Fossils are rare in this formation here; Leperditia alta (Conrad) and L. scalaris Jones occur throughout the bed and segments of Eurypterus have been found 2 or 3 feet below the top of the bed.

Manlius limestone

This formation is prominent in the stratigraphy of Onondaga and Cayuga counties, but thins out rapidly in a westerly direction and does not reach the McQuan quarry which affords the only exposure of its horizon on this quadrangle. Flagstones and building blocks reported to be from an old quarry in the south part of Seneca Falls, are Manlius limestone, from which it is evident that it extends to the vicinity of that village.

When freshly quarried the rock is very dark and hard, but when weathered shows a straticulate structure and fades to a dull bluish gray color.

It contains many fossils of which the more common are Spirifer vanuxemi Hall, Stropheodonta varistriata Conrad and Leperditia alta (Conrad).

DEVONIC

Oriskany sandstone

The Helderbergian series of limestones that in eastern New York constitute the basal formations of the Devonic system all thin out in a westerly direction and disappear before reaching Cayuga county and in western central New York the Siluric waterlimestones are succeeded in some localities by thin lentils of coarse quartzitic Oriskany sandstone, cross-sections of ancient sandbars.

Where the sandstone is absent, as in the McQuan quarry which affords the only exposure of the Oriskany horizon on these quadrangles, the Rondout waterlime is separated from the Onondaga limestone by a thin layer of black carbonaceous matter 3 to 6 inches thick containing pebbles of waterlime and grains of black sand, but no fossils.

In Yawger's woods 2 miles northeast of Union Springs and 8 miles southeast of the McQuan quarry the Oriskany sandstone is 4 feet 6 inches thick and crowded with characteristic fossils mostly large brachiopods (Hipparionyx proximus, Spirifer

arenosus, S. murchisoni, Chonostrophia complanata, Rensselaeri ovides, etc.). A thin stratum of this sandstone is exposed in the bed of Flint creek at Phelps, and at Buffalo the loose sands of Oriskany time sifted into fissures in the Cobleskill limestone, producing small sand "dikes."

Onondaga limestone

This appellation was first used by James Hall in the third annual report of the Fourth Geological District for 1838, page 309, and applied to "the gray crinoidal or Onondaga limestone which follows the Oriskany sandstone and is well characterized and distinguished from any other by its peculiar gray or grayish blue color and compact crystalline structure. Sometimes layers of chert or hornstone are interspersed between those of the limestone; and some of those contain much of that mineral while in others it occurs only in small nodules. When the lower layers abound in chert they contain few or no fossils while those containing little of it are full of them."

The upper beds are described on page 310 as the "Seneca limestone" which "succeeds the Onondaga and in some instances alternates with it. It is recognized by its darker blue color, fine texture and homogeneous structure. Like the Onondaga it contains much chert or hornstone."

Vanuxem, in the report on the third district for that year, page 274, describes the lower beds as the "gray sparry crinoidal limestone" and says, "This limestone is but a thin mass of from 8 to 12 feet in thickness" and on page 275 he speaks of the upper beds as "Seneca limestone. This rests upon layers of cornitiferous."

In 1824 Prof. Amos Eaton in *A Geological and Agricultural Survey of the District Adjoining the Erie Canal* introduced the name *Cornitiferous limerock* for a formation which evidently includes both the Onondaga and the Seneca limestones. He repeated his definition with the addition of other localities in his *Geological Nomenclature for North America*, 1828, page 25, and in the first edition of his *Geological Text Book*, 1830, page 42. He changed the name to *Corniferous limestone* in the *American Journal of Science* for 1839.

In the Final Report on the Fourth Geological District, 1843 Professor Hall redescribes the Onondaga as "included in the Corniferous limerock by Professor Eaton" and applies the term "Corniferous limestone" as equivalent to the "upper part of the Corniferous limerock of Eaton, Seneca limestone of the annual reports."

In volume 3, *Palaeontology of New York,* 1859, pages 42–45, the Onondaga and Corniferous limestones, together with the Schoharie grit and the Cauda-galli grit which do not extend as far west as these quadrangles are classified as composing the "Upper Helderberg group" and this term has been widely used, specially in connection with the fauna of those beds.

Investigations subsequent to the geological survey of 1837–42 have led to the conclusion that there are no well defined structural changes in the character of the limestones in this formation that are continuous for more than a short distance, the exceedingly irregular distribution of the chert making its presence or absence of no value as a guide to their stratigraphy, and the clearer subcrystalline character of the basal layers at some localities being due to aggregations of corals, crinoid stems and other fossils in a manner suggestive of coral reefs, in which the species are mainly if not entirely those found to occur in greater or less abundance in the higher beds.

In the reports of the fourth and third districts for 1838 in which the name Onondaga was first applied to the limestone as a unit term Hall and Vanuxem also used this word as a group term to designate the "Saliferous group of Onondaga," changing in the report for the succeeding year to "Onondaga salt group," thus duplicating the use of the word.

In 1899 Clarke and Schuchert in a revised *Classification of the New York Geologic Formations* eliminated "Onondaga" as a group term and continued it as a unit term in compliance with the rules of geologic nomenclature, its application being expanded to cover all of the limestone strata between the Oriskany sandstone horizon and Marcellus shale, which for reasons above stated are considered as constituting one formation. The name Seneca thus discontinued as a unit term, has been employed as the designation of a period or group (Senecan) for the formations extending from the top of the Hamilton to the top of the Portage beds.

The formation consists of a heavy deposit of limestone, very dark when freshly quarried but on exposure weathering to a light bluish gray color. Its line of outcrop from the Hudson river valley to Buffalo is marked by hundreds of quarries that have produced and are still producing enormous quantities of handsome and durable building stone, and valuable fluxing road material. Until recently the manufacture of quicklime from these beds was also an important branch of business.

It is 75 to 80 feet thick on this quadrangle and is composed of a series of even layers 6 inches to 3 feet in thickness separated by thin partings of shale or chert, these layers being usually divided by vertical joints into large rectangular blocks. At the base a few layers having usually a total thickness of 5 to 8 feet are composed largely of corals and are specially desirable for house trimmings.

Chert or hornstone, varying in color from black to light blue is unevenly distributed through a considerable part of the higher beds, occurring in nodular layers or rows of separate nodules, on the surface of the strata or compactly imbedded within them. Fragments of these cherty beds are scattered over the country south of the line of outcrop to which the protruding flinty nodes give a peculiarly scraggy appearance.

While the layers that contain a considerable proportion of chert are less valuable for building purposes, they afford in unlimited quantities the best quality of road metal found in western New York.

The area over which the Onondaga limestone is the surface rock in the Geneva quadrangle is divided by the Seneca river about equally, that part on the north side being mainly in a low flat region in which the rock is entirely covered by drift or alluvium.

A small outcrop of shaly limestone 2 miles north of Geneva and west of the Auburn branch of the New York Central Railroad is the only exposure of the Onondaga limestone on this quadrangle north of the river and lake. In the region adjacent to the river on the south side there is an average northward slope of 50 to 60 feet per mile on the surface and the drift mantle being but a few feet thick the rock appears in the fields and along the streams in many places.

The best exposures are afforded by the extensive quarries of which there are 10 or more in an irregular row beginning on the river bank a mile west of Waterloo and extending toward the southeast to the vicinity of Canoga. The basal layer is exposed slightly in McQuan's quarry and the cherty strata next above it at the Waterloo dam.

In the old quarry near the Lehigh Valley Railroad a mile west of South Waterloo, 25 feet of the beds just above the middle of the formation may be seen and the same horizon is now exploited in the Thomas Brothers quarry half a mile south of Waterloo; also

in the Rorison quarry 2½ miles farther toward the southeast, and in others nearer Canoga. That these quarries are in the same horizon is shown by the appearance in each of a seam of soft grayish shaly marlyte 6 to 8 inches thick easily distinguished from other shaly partings in these beds. It overlies a nodular layer of chert 3 to 5 inches thick, but the rock for 10 to 12 feet above and below it is quite free from chert and in even tiers of convenient thickness, and therefore specially desirable for building purposes.

The upper layers appear along the bed of the stream that crosses the Waterloo-Romulus road 1½ miles southeast of Waterloo and in an old quarry by the roadside ¾ miles northeast of Kuneytown.

The fauna of the Onondaga limestone is a large one, the lists of the species given in New York State Museum bulletin 63 for the Canandaigua and Naples quadrangles containing 3 fishes, 39 crustaceans, 13 cephalopods, 3 pteropods, 38 gastropods, 15 lamellibranchs, 48 brachiopods, 4 crinoids and 30 corals, total 193.

Marcellus shale

This formation was described by both Hall and Vanuxem as admitting of division into two parts. The former says on page 177 of the Report on the Fourth Geological District, 1843: "The lower is very black, slaty and bituminous and contains iron pyrites in great profusion; some portions are calcareous and it is always marked by one or more courses of concretions or septaria which are often very large. This division terminates upward by a thin band of limestone above which the shale is more fissile and gradually passes from black to an olive or dark slate color." The limestone here referred to is now known as the Stafford limestone; it is 8 to 10 feet thick in Erie county, but thins out toward the east and is not known beyond Flint creek in Ontario county where it is but 4 inches thick. Its place in Seneca and Cayuga counties is shown by a thin band of lighter colored shales containing many of the fossils common in the limestone.

The term Marcellus shale is now restricted to the beds between the Onondaga limestone and the horizon of the Stafford limestone, and the beds formerly known as upper Marcellus are now designated Cardiff shale.

In Onondaga county and farther east the transition from the Onondaga limestone to the black Marcellus shale is abrupt, and clearly defined, but in the succeeding 15 feet of rock there are interstratified several thin layers of dark limestone and at the top of

these basal beds there occurs the 2 foot stratum known to geologists as the Agoniatite limestone which extends to the western part of the State and is readily distinguished by its peculiar character and fossils.

The shales intervening between the Onondaga limestone and Agoniatite limestone become more calcareous westward from Marcellus and at Union Springs are mostly dark impure bituminous limestone, more or less shaly. On this quadrangle and in Ontario and Livingston counties they are still more calcareous and lighter colored and in the western part of the state are so far assimilated to the Onondaga limestone as to be not separable from that formation.

Above the Agoniatite limestone a row of large spherical concretions and a few thin calcareous flags are the only variations in the bed of densely black shale up to the horizon of the Stafford limestone. The Marcellus black shale has a thickness of 45 feet on the Geneva quadrangle. It is exposed along the bed of a small stream that crosses the Romulus road 2 miles south of Waterloo; in the bed of Kendig creek and on the east shore of Seneca lake south of the outlet; also, slightly in the road a mile west of Canoga spring.

The following is a list of the more common fossils of the Marcellus black shale:

Orthoceras subulatum *Hall*
Styliolina fissurella (*Hall*)
Pleurotomaria rugulata *Hall*
Nuculites oblongatus *Conrad*
Chonetes lepidus *Hall*
C. mucronatus *Hall*
Strophalosia truncata *Hall*
Liorhynchus limitare (*Vanuxem*)
L. multicosta *Hall*

Cardiff shale

In the absence of the Stafford limestone on this quadrangle, the Cardiff shale here succeeds directly the Marcellus shale as above described and is equivalent to the " Upper shale of Marcellus " of Vanuxem for which the name here used was substituted in New York State Museum bulletin 63, 1904, from its abundant exposure in the vicinity of Cardiff, Onondaga co.

As compared with the shale below the Stafford limestone the Cardiff shale is more argillaceous and fissile and gradually passes from black to an olive or dark slate color.

At the base of the formation a band of calcareous shale 2 feet thick in the horizon of the Stafford limestone is lighter colored and more fossiliferous than the succeeding beds, which are mostly dark and bituminous. In the upper part there are thin lentils of lime-

stones composed usually of shells of the brachiopod, Liorhynchus limitare.

The densely black color and highly bituminous character of the Marcellus and Cardiff shales in central and western New York led to their frequent exploitation in pioneer days, in the mistaken belief that they were the surface outcrops of beds of coal. In recent years, as one result of their penetration in hundreds of deep borings they are known to searchers for natural gas as the "gas-bearing rocks."

Fossils are abundant in the lower Cardiff shales which contain many species found in the Stafford limestone that separates the Cardiff from the Marcellus shale in Ontario county and westward to Lake Erie. The more common of these are:

Phacops rana *Green*
Cryphaeus boothi *Green*
Homalonotus dekayi *Green*
Orthoceras subulatum *Hall*
Styliolina fissurella *Hall*
Pleurotomaria rugulata *Hall*
P. itys *Hall*
P. capillaria *Conrad*
P. sulcomarginata *Conrad*
Camarotoechia sappho *Hall*
Spirifer audaculus *Conrad*
S. fimbriatus *Conrad*

The upper shales are much less fossiliferous than the lower but the following forms are fairly common:

Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
Liorhynchus limitare *Vanuxem*
Orbiculoidea minuta *Hall*
Pterochaenia fragilis *Hall*
Tornoceras discoideum *Conrad*

The Cardiff shales are exposed along the Lehigh Valley Railroad on the east side of Seneca lake near the foot, along Kendig creek at and above the forks and along the stream on the east side of the Romulus road 2 miles south of Waterloo. Other small outcrops occur in the southeastern part of the town of Fayette.

Skaneateles shale

This name was first applied to the beds that succeed the Cardiff shale at the foot of Skaneateles lake by Vanuxem in the Report of the Third District for 1839, page 380. In the final report, 1843, it is included in the "Hamilton group" which he says "includes all of the masses between the upper shales of Marcellus and the Tully limestone."

Hall, in the Report on the Fourth District, page 177, says "there

is little advantage in separating the upper division of this (Marcellus) shale from the Hamilton group. The line of separation is nowhere well marked, the change in lithological character being gradual, while some of the fossils continue from one to the other."

On page 187 of that report, in describing the Hamilton group he says: "Along the banks of these lakes (Seneca and Cayuga) I have been able to trace the following subdivisions which hold good over considerable areas but which can not be relied on in every instance.

1 Dark, slaty fossiliferous shale, which rests directly upon the Marcellus. . . not very abundant in fossils.

2 Compact calcareous blue shale often passing into an impure limestone, thin and worthy of notice only from being somewhat persistent and marking the point of separation between two or more important shaly masses.

3 An olive, or often bluish fissile shale, resting upon the last named mass.

4 Ludlowville shale.

5 Encrinal limestone.

6 Moscow shale."

The first three of these subdivisions differ so slightly in both lithologic and faunal characteristics that they have been pretty much lost sight of as such, the loose term "lower Hamilton" having been commonly used for all the beds between the Cardiff and Ludlowville shales.

The Skaneateles shale, as the term is used in this bulletin, comprises 1, 2 and 3 of the above specified subdivisions. Its estimated thickness here is 200 feet, but owing to the general flatness of the region over which it is the surface rock there are no favorable exposures. The upper layers outcrop along a small stream 1 mile south of Fayette and the basal layers ¾ mile north of that village. The contact with the succeeding Ludlowville shale may be seen in the cliffs at the falls in the lower part of Big Hollow creek 3 miles north of Hayt Corners; in the ravine 1½ miles farther north at top of falls; along Reeder creek, a mile south of Varick station; and on the shore of Seneca lake north of Dey landing. The upper beds are also well displayed on the west side of Seneca lake in the ravine of Wilson's creek at and below the falls.

Fossils are less common in the Skaneateles shale than in the higher subdivisions of the Hamilton group, but the collector may expect to find good specimens of the following forms:

Phacops rana *Green*
Styliolina fissurella (*Hall*)
Pleurotomaria rugulata *Hall*
Lunulicardium curtum *Hall*
Nuculites oblongatus *Conrad*
Chonetes setiger *Hall*
Spirifer mucronatus (*Conrad*)
Ambocoelia umbonata *Conrad*
Liorhynchus limitare (*Vanuxem*)
L. multicosta *Hall*

Ludlowville shale

The transition from the Skaneateles to the Ludlowville shale is gradual through a few feet in which the rock becomes lighter colored, slightly arenaceous and more fossiliferous. These passage beds are succeeded by a hard calcareous stratum containing corals, large brachiopods and many other forms. This stratum is continuous for many miles in central New York producing falls or cascades in numerous ravines. It partakes of the general character of the entire group in becoming more arenaceous toward the east and calcareous toward the west.

It was described by Clarke in the Report of the New York State Geologist for 1884, pages 12 and 13, as it appears at Centerfield in Ontario county, under the name Basal limestones.

Lincoln refers to it under the same name in "Geology of Seneca County" [Report of the New York State Geologist, 1894, p. 93]. It is the "Centerfield limestone" at the base of the Canandaigua (Ludlowville) shales described in New York State Museum bulletin 63, 1904. It is well exposed on these quadrangles at the top of the falls in Big Hollow creek, at the top of the falls in the ravine 3 miles east of Romulus, along a small stream 1½ miles south of Fayette, in Kendig creek at MacDougall, along Reeder creek and at Dey landing, also on the west side of the lake at the top of the falls of Wilson's creek, near the west line of the quadrangle.

The succeeding middle beds are generally soft, gray sandy shale with concretions, calcareous lentils and thin sandy flags, in all of which fossils are common but rather less abundant than in the lower and upper parts of the formation. The upper part is mostly soft gray argillaceous shale, though bands of coarser sediment occur near the top in which fossils are very abundant and the rock quite calcareous.

The entire formation shows the increase of arenaceous matter toward the east, bands of sandstone in the horizon of the Ludlowville shales producing escarpments on the sides of Onondaga valley, and at Hamilton in Madison county, affording a fair quality of building stone.

The upper limit of this formation is distinctly marked by the Tichenor limestone that from Onondaga county to Lake Erie is the succeeding formation and produces a large number of cascades or falls below the top of which the Ludlowville shales are exposed.

The best exposures of these beds on these quadrangles may be found below the falls in Bloomer and Fall creeks, 2 miles east of Hayt Corners; along Kendaia creek, on the shores of Seneca lake between Dey landing and the mouth of Indian creek and on Indian creek at the forks. It is finely displayed in the cliffs along the lake shore from a mile north of Dresden for 4 miles; also in the lower part of the Kashong creek ravine to the top of the middle falls. In New York State Museum bulletin 63, accompanying the stratigraphic and paleontologic map of the Canandaigua-Naples quadrangles the following species are listed as having been found in the basal limestones and succeeding Canandaigua (Ludlowville) shales and which are the essential components of the Hamilton fauna in this region:

Worms
Arabellites
Oenonites
Eunicites
Spirorbis angulatus *Hall*
Cornulites tribulis *Hall*
C. mitella *Hall*

Crustaceans
Phacops rana *Green*
Dalmanites boothi (*Green*)
D. boothi *var.* calliteles (*Green*)
Proetus rowi (*Green*)
P. macrocephalus *Hall*
Cyphaspis ornata *Hall*
C. ornata *var.* baccata *Hall & Clarke*
C. craspedota *Hall & Clarke*
Turrilepas devonica *Clarke*
T. squama *Hall & Clarke*
T. nitidula *Hall & Clarke*
T. foliata *Hall & Clarke*
T. tenera *Hall & Clarke*
Schizodiscus capsa *Clarke*

Ostrocodes
Estheria pulex *Clarke*

Pteropods
Styliolina fissurella (*Hall*)
Hyolithus aclis *Hall*

Cephalopods
Orthoceras exile *Hall*
O. nuntium *Hall*
O. crotalum *Hall*
Nautilus liratus *Hall*
Tornoceras uniangulare (*Conrad*)
Bactrites tenuicinctus (*Hall*)

Gastropods
Bellerophon leda *Hall*
B. lyra *Hall*
B. acutilira *Hall*
Platyceras symmetricum *Hall*
P. erectum *Hall*
P. conicum *Hall*
P. attenuatum *Hall*
P. thetis *Hall*
P. bucculentum *Hall*
P. carinatum *Hall*
P. echinatum *Hall*
P. subspinosum *Hall*
Pleurotomaria capillaria *Conrad*
P. itys *Conrad*
P. trilix *Hall*
P. disjuncta *Hall*
P. lucina *Hall*
Loxonema delphicola *Hall*
L. hamiltoniae *Hall*

Diaphorostoma lineatum (*Conrad*)
Cyclonema hamiltoniae *Hall*
C. multilira *Hall*
Straparollus rudis *Hall*
Murchisonia micula *Hall*
Macrochilus hebe *Hall*

Lamellibranchs

Mytilarca oviformis (*Conrad*)
Macrodon hamiltoniae *Hall*
Microdon bellistriatus *Conrad*
Buchiola halli *Clarke*
Cypricardinia indenta (*Conrad*)
Modiella pygmaea *Hall*
Conocardium crassifrons *Conrad*
Grammysia arcuata (*Conrad*)
Goniophora acuta (*Hall*)
Modiomorpha mytiloides *Hall*
M. concentrica (*Conrad*)
M. macilenta *Hall*
Nuculites oblongatus *Conrad*
Actinopteria decussata *Hall*
Aviculopecten princeps (*Conrad*)
Palaeoneilo constricta (*Conrad*)
P. emarginata (*Conrad*)
P. fecunda *Hall*
P. plana *Hall*
P. tenuistriata *Hall*

Brachiopods

Lingula leana *Hall*
L. densa *Hall*
Crania crenistria *Hall*
Craniella hamiltoniae *Hall*
Rhipidomella penelope *Hall*
R. vanuxemi *Hall*
Orthothetes arctostriatus *Hall*
O. pandora (*Billings*)
Stropheodonta concava *Hall*
S. demissa (*Conrad*)
S. (Douvillina) inequistriata (*Conrad*)
S. junia *Hall*
Pholidostrophia nacrea *Hall*
Leptostrophia perplana (*Conrad*)
Chonetes carinatus *Conrad*
C. lepidus *Hall*
C. deflectus *Hall*
C. scitulus *Hall*
Productella navicella *Hall*
P. spinulicosta *Hall*
P. tullia *Hall*
Spirifer angustus *Hall*
S. divaricatus *Hall*
S. fimbriatus (*Conrad*)
S. audaculus (*Conrad*)
S. mucronatus (*Conrad*)
S. consobrinus *d'Orbigny*
S. marcyi *Hall*
S. granulosus (*Conrad*)
Ambocoelia umbonata *Conrad*
A. praeumbona *Hall*
Cyrtina hamiltonensis *Hall*
Nucleospira concinna *Hall*
Parazyga hirsuta *Hall*
Cyclorhina nobilis *Hall*
Trigeria lepida *Hall*
Meristella haskinsi *Hall*
Athyris spiriferoides (*Eaton*)
Atrypa reticularis (*Linné*)
Camarotoechia dotis *Hall*
C. horsfordi *Hall*
C. prolifica *Hall*
C. sappho *Hall*
C. congregata (*Conrad*)
Liorhynchus multicosta *Hall*
L. quadricostatum (*Vanuxem*)
Pentamerella pavilionensis *Hall*
Cryptonella rectirostris *Hall*
C. planirostris *Hall*
Eunella lincklaeni *Hall*
Tropidoleptus carinatus (*Conrad*)

Crinoids

Platycrinus eboraceus *Hall*
Megistocrinus ontario *Hall*
Nucleocrinus lucina *Hall*
Dolatocrinus glyptus *Hall*
D. liratus *Hall*

The following corals were found in the basal limestones:

Zaphrentis halli *Edwards & Haime*
Z. simplex *Hall*
Cystiphyllum varians *Hall*
C. conifolle *Hall*
C. americanum *Edwards & Haime*
Cyathophyllum robustum *Hall*
C. nanum *Hall*
C. conatum *Hall*

Amplexus hamiltoniae *Hall*
Heliophyllum halli *Edwards & Haime*
H. irregulare *Hall*
H. reflexum *Hall*
H. obconicum *Hall*
H. confluens *Hall*
Favosites placenta *Rominger*
F. arbusculus *Hall*
F. argus *Hall*
Alveolites goldfussi *Billings*
Pleurodictyum stylopora *Eaton*
Striatopora limbata *Eaton*

Tichenor limestone

The thin, but widely extended stratum of limestone that separates the Ludlowville from the Moscow shale was first described in the Third Annual report of the Fourth Geological District for 1838, page 298, by Professor Hall as it appears in Seneca county. In that report it is considered as "the terminating rock of the shale last described" (Ludlowville) under the designation Encrinal limestone from the abundance of fragments of crinoidal columns it contains.

In the final report on the fourth district, page 187, it is described as one of the divisions of the Hamilton group. The term "Tichenor" was substituted for "Encrinal" in the title of this formation in *Classification of New York Series of Geological Formations* by Clarke and Schuchert, 1900, from its well known favorable exposure at Tichenor point, Canandaigua lake.

This formation is a thin stratum of calcareous sediment that varies in character from a light colored compact blue limestone a few inches thick to a mass of hard calcareous shale with a thin uneven limestone at the base and other thin lentils of similar character interstratified in the succeeding 4 to 6 feet of shale.

The compact layer has a subcrystalline appearance when broken, due to the fragmentary crinoidal columns, and the surface is at some localities marked by an abundance of Spirifer granulosus, conspicuous for its great size. Otherwise this stratum is not usually very fossiliferous, but the overlying shales are rich in fine specimens of forms common in the shale above and below. Among the fossils found in the Tichenor limestone are:

Phacops rana *Green*
Orthoceras coelamen *Hall*
O. exile *Hall*
Lyriopecten orbiculatus *Hall*
Spirifer granulosus (*Conrad*)
S. mucronatus (*Conrad*)

The more favorable exposures of the Tichenor limestone on these quadrangles may be found at the top of the lower falls in the ravines of Bloomer falls and other creeks 2 miles east of Hayt

Corners; at the forks of Indian creek a mile north of Willard and on the west side of Seneca lake in a small ravine 1½ miles north of Dresden 6 rods above the New York Central Railroad and at the crest of the middle falls in the ravine of Kashong creek.

Moscow shale

This term was applied by Hall in the Third Annual Report of the Fourth District, page 298, to the shales that succeed the Tichenor limestone and are terminated above by the Tully limestone. Following a description of this, the upper division of the Hamilton group, as it appears in Seneca county along the shores of Seneca and Cayuga lakes, he says: "This shale is so well developed, and contains the fossils, particularly the trilobites, in such great perfection, at Moscow, Livingston co., that I have given it that name. . ."

As developed on these quadrangles the formation may be described as a soft mass of gray calcareous shale, very fossiliferous and light colored in the lower beds, the upper being darker, more argillaceous and containing fewer and smaller fossils. As a whole the formation generally assumes the character of the lower beds in a westerly direction and of the upper beds toward the east. At Moscow the dark upper beds are but 11 feet thick while on these quadrangles they constitute about one third the thickness of the formation and in Onondaga and Madison counties, they occupy all of the space but a few feet at the bottom, between the horizon of Tichenor and the Tully limestone.

Concretionary calcareous layers, some of which are continuous for a considerable distance, while others extend but a few feet, composed of an agglomeration of fossils are of frequent occurrence in the lower beds and to a much less degree in the upper, and irregularly formed concretions, also containing many fossils, are common throughout the entire formation.

The list of fossils that compose the fauna of the Moscow shales in the Canandaigua lake section published in Museum bulletin 63, contains 6 worms, 18 crustaceans, 7 cephalopods, 3 pteropods, 21 gastropods, 34 lamellibranchs, 52 brachiopods, 18 bryozoans, 5 corals and 26 crinoids, a total of 190 species.

Exposures in which the entire section of the Moscow shales are accessible may be found in several ravines 1 to 2 miles east of Hayt Corners. The lower part is displayed along Indian creek

and its eastern branches and the upper part in Simpson creek in the State Hospital grounds at Willard below the Tully limestone at the quarry, and in the cliffs at Perry point and the adjacent ravine. They appear in the banks of the Keuka outlet and the floor and sides of Bruce's gully afford an ideal display of the upper shales conveniently situated for the collection of fossils, and the entire section may be seen in the Kashong creek ravine between the top of the middle fall and the Tully limestone at the crest of the upper fall.

Tully limestone

The Tully limestone, so named by Vanuxem in the Third Annual Report of the Third Geological District for 1838, from large exposures and superior development in the town of Tully, Onondaga co., is specially interesting not only on account of its own composition and structure, but also from the fact that it is interstratified 250 feet below the top of a series of soft shales that succeed the Onondaga limestone for a thickness of a thousand feet and in which the Tichenor is the only other continuous limestone. The rock is fine grained blue black rather impure limestone that weathers light bluish gray. It is very compact and hard when fresh, but brittle, breaking easily under the hammer and, after long exposure, inclined to crumble into small angular fragments. This tendency impairs the value of this limestone for building purposes, and its impurity for the production of quicklime for which purposes it was formerly quarried to a considerable extent. Its chief economic value at present lies in its adaptability as road metal and in the manufacture of Portland cement.

It is 9 to 15 feet thick on these quadrangles and usually separated into 4 or 5 distinct layers, the lower one 5 to 7 feet thick, the others varying from 1 to 3 feet. Frequent joints divide the strata into massive blocks and these are strewn along the ravines and the lake shore at the foot of the cliffs in which the limestone occurs. The change from the soft dark Moscow shale to the Tully limestone is abrupt, but at the top the overlying Genesee shale is quite calcareous for 3 to 5 feet.

The Tully limestone is an important, easily recognized and reliable stratigraphic datum plane from Chenango county on the east where it is 30 feet thick to Gorham, Ontario co., on the west, where it disappears by thinning out. It is 9 feet thick at the head of the Kashong creek ravine; 12 feet, 6 inches to 13 feet, 6 inches along the Keuka outlet; 14 feet, 6 inches at Miller point; 14 feet at Lodi

glen; 13 feet in the quarry at Willard; 11 feet with possibly one or two layers at the top wanting in the old Johnson quarry 1½ miles north of Ovid; and 14 to 15 feet in the ravines east of Hayt Corners.

The lighter color and rugged character of the Tully as compared with the soft dark shales above it, make it a prominent feature in the stratigraphy of the cliffs on the lake shore and in the adjacent ravines. Its line of outcrops on these quadrangles is more than 30 miles long and the frequency and extent of the exposures make it possible to ascertain its position in reference to the lake level with a good degree of accuracy. At the head of the Kashong creek ravine the top of the limestone is 713 feet A. T., with a northward dip that is reversed a little farther south, as it is 560 feet A. T. in a small quarry 1½ miles north of Dresden, and has the same elevation at the Cascade mills in the Keuka outlet gorge. At the mouth of Bruce gully it is 550 feet A. T. rising southward to 600 feet A. T. at the top of the falls in that ravine, and westward to the same elevation at Seneca mills a mile west of Cascade mills. In the Perry point ravine it is 565 feet A. T. Thence southward for 4 miles it is covered by drift to a ravine half a mile north of Plum point where it is 478 feet A. T.

It sinks below lake level 444 feet A. T. on the north side of Plum point, rises 5 feet above in a small arch half a mile farther south, is covered by water for 60 rods, then rises to the hight of 45 feet above the lake in an anticlinal that holds it above the water across Severne point and to the north side of Miller point where with a 2 degree southward dip it finally disappears below the lake level.

Its emergence on the east side is covered by drift, its southern exposure being 50 rods from the lake and 50 feet above it in a small ravine 1 mile south of Lodi Landing. A strong southward dip carries it below the lake level between this ravine and a small gully ¼ mile farther south at the mouth of which the black Genesee shale is exposed. It appears at the mouth of Lodi glen 30 feet above the lake rising continually up the ravine for 75 rods showing a northwestward dip of about 100 feet per mile.

It is prominently displayed in the cliffs and ravines north of Lodi Landing as a slightly undulatory light gray band 40 to 60 feet above the lake level for 3 miles, then sinks to partial submergence ¾ of a mile south of the dock at Willard. It is 150 feet higher in the quarry on Simpson's creek ⅝ mile northeast. Its next outcrop is in the old Johnson quarry 1½ miles north of Ovid at the summit

of the ridge that separates the Seneca from the Cayuga lake valley, 840 feet A. T., 395 feet higher than in the depression where it last appears on the lake shore 3½ miles west and but 2 miles farther south.

From this point it descends to 800 feet A. T. in an outcrop near the railroad station at Hayt Corners; 715 feet A. T. in Fall creek; 680 feet A. T. in the next ravine south, and 640 feet A. T. under the bridge over the third ravine, or 160 feet in 1⅜ miles east and ¾ mile south.

At the top of the falls in the Barnum creek ravine it is 680 feet A. T. dipping as everywhere in this immediate vicinity at the rate of 100 to 150 feet per mile toward the southeast. It disappears under Cayuga lake 381 feet A. T. ⅞ of a mile southeast of Little point and 10 miles southeast of its last outcrop on these quadrangles.

Fossils are not generally common in the Tully limestone, but usually may be found in one or more of the layers in considerable numbers at each outcrop.

These are in matter of number species of the fauna below but the presence of the brachiopod Hypothyris cuboides Sowerby (Rhynchonella venustula Hall) gives it definite stamp as a formation which must be regarded the earliest member of the Upper Devonic.

Genesee shale

In the annual and final reports of the fourth geological district, Professor Hall considered the heavy bed of black and dark shales that succeeds the Tully limestone as constituting one formation known at first as the "Upper black shale" to distinguish it from the Lower or Marcellus shale, but later designated "Genesee shale" from its exposure in the Genesee valley. He recognized, however, a marked difference between the upper and lower beds in both lithologic character and the fossils they contain, referring to them frequently as "Upper Genesee" and "Lower Genesee."

On page 422 of the report for 1839 he says: "In this neighborhood, (the Genesee valley in the vicinity of Geneseo) the black shale is succeeded by a thin stratum of limestone." Subsequent investigations under his direction have shown this to be the Genundewa (Styliola) limestone, which is continuous from Ontario county to Lake Erie, interstratified not far from the middle of the beds and that it is the only continuous layer of limestone in that region above the Tichenor limestone.

For these and other reasons more fully set forth in Museum bulletin 63, the use of the term Genesee shale is restricted to beds between the Tully and the Genundewa limestones in Ontario county and westward and, on these quadrangles where the latter does not appear, to a band of calcareous shales and row of fossiliferous concretions in its horizon.

The Genesee shale is a homogeneous mass of densely black thinly laminated bituminous shale that after exposure becomes fissile and splits into flat plates. The beds are usually traversed by approximately parallel series of joints that intersect each other at different angles producing on the surface of horizontal exposures triangles, diamonds, rhomboids and other kindred forms, and in cliffs striking effects like bastions and buttresses. In old exposures the outward angles have been worn away and there are left rounded masses of black shale partly covered in sheltered places by a thin white efflorescence of alum produced by the decomposition of the contained iron pyrites. The formation is 90 feet thick on the Keuka outlet and 75 feet at the east line of the quadrangle.

It is usually exposed more or less favorably wherever the Tully limestone crops out but the following are some of the more accessible localities where it may be seen: in the cliffs and ravine on the south side of the Keuka outlet at Cascade mills; in the lower part of the ravine of Plum creek; along the lake shore and in ravines between Miller point and Starkey point; on the east shore between Faucetts point and Lamoreaux Landing; in all of the ravines in the vicinity of Lodi Landing; in the railroad cut at Willard; in the highway north of Ovid, and in all of the ravines southeast of Hayt Corners.

Fossils are exceedingly rare in the Genesee shale, the densely black portion being practically barren though an occasional lignite and a few conodont teeth are found in them.

The less bituminous shales contain:

Pleurotomaria rugulata *Hall*
Styliolina fissurella *Hall*
Pterochaenia fragilis (*Hall*)
Lingula spatulata *Vanuxem*
Orbiculoidea lodensis (*Vanuxem*)
Liorhynchus quadricostatum (*Vanuxem*)
Probeloceras lutheri *Clarke*
Bactrites aciculum (*Hall*)

Genundewa limestone horizon

In Ontario county and westward to Lake Erie the Genesee shale is succeeded by a band of thin nodular limestones composed principally of myriads of the minute shells of S t y l i o l i n a **f i s s u -**

r e l l a and containing many other species not found below that horizon. This calcareous band formerly known as the Styliola limestone was designated Genundewa limestone in New York State Museum bulletin 63, from its favorable exposure at Genundewa point on Canandaigua lake. The layers of limestone do not appear on these quadrangles, their most eastern exposure being in a small ravine 2½ miles south of the village of Gorham, Ontario co. but in their place a distinctly marked band of soft gray calcareous and fossiliferous shale is found that has at its base a row of large flattish concretions which in the cliffs south of Big Stream point on Seneca lake and a few other localities form a continuous layer of rather soft concretionary limestone.

The formation emerges from the lake at Starkey point on the west side and Faucetts point on the east and is displayed in the cliffs toward the north with fallen concretions and blocks of the gray shale strewn along the beach beneath. It may be seen in the walls of Lodi glen and other ravines, and is accessible in the Lehigh Valley Railroad cut at Willard. It is covered by drift in the eastern part of the quadrangle.

An anticlinal fold brings the concretionary limestone above the water south of Big Stream point (Glenora) 2½ miles south of these quadrangles. This is the locality referred to by Professor Hall on page 214 of the Report of the Fourth Geological District under an erroneous impression that it was Tully limestone.

This formation was described by Dr D. F. Lincoln on pages 99 and 100 of the Fourteenth Annual Report of the New York State Geologist and correlated as the base of the Portage group. The fossils collected by him from this gray band on Seneca lake were identified by Dr Clarke as follows:

Manticoceras patersoni (*Hall*)
Bactrites *sp.*
Gomphoceras *cf.* manes *Hall*
Paleotrochus praecursor *Clarke*
Pleurotomaria capillaria *Conrad*
Loxonema noe *Clarke*
Loxonema *var.*
Styliolina fissurella *Hall*
Buchiola retrostriata (*v. Buch*)
Palaeoneilo muta *Hall*
Pterochaenia fragilis (*Hall*)
Atrypa reticularis *Linné*
Ambocoelia umbonata *Hall*
Sp. *cf.* subumbona
Chonetes scitulus *Hall*
Liorhynchus mesacostalis *Hall*
L. globuliformis (*Vanuxem*)
Orthothetes *sp.*
Orbiculoidea lodensis (*Vanuxem*)
Orbiculoidea, small form
Lingula spatulata *Vanuxem*
Cladochonus, abundant in the concretions

West River shale

Succeeding the Genundewa limestone horizon there is a heavy bed of dark and black shales referred to in the early reports as the upper beds of the Genesee shale. In Ontario county and westward there is a distinctive difference between the lower dark gray fossiliferous and slightly calcareous shales and the densely black and bituminous shales of the upper part from which they are separated by a few feet of hard blue shales and thin flags. They become more homogeneous toward the east and although the difference is discernible to the careful observer, on the west side of Seneca lake it is not very clearly defined and in the Cayuga lake valley is not recognizable.

For this reason the dark shales that in this quadrangle lie between the Genundewa limestone horizon and the base of the Cashaqua are included in one division as West River shale so named from their abundant exposure in the West River valley in Yates county. The formation is well displayed in the ravine of Plum creek; along the lake shore at Starkey point and the cliffs at the south, near Faucetts point on the east side of the lake and in nearly all of the ravines toward the north to Willard.

Fossils are exceedingly rare in the upper and more bituminous beds and not at all common in the lower, from which the following species have been obtained:

Bactrites aciculum *Hall*
Gephyroceras *sp.*
Pleurotomaria rugulata *Hall*
Buchiola retrostriata (*v. Buch*)
Pterochaenia fragilis (*Hall*)
Panenka *sp.*
Lunulicardium curtum *Hall*
Lingula spatulata *Vanuxem*
Orbiculoidea lodensis (*Vanuxem*)
Liorhynchus quadricostatum (*Vanuxem*)
Melocrinus clarkei *Williams*

Cashaqua shale

This formation, which receives its name from its exposure along Cashaqua creek in Livingston county, is there a bed something more than 100 feet thick of light, soft, rather calcareous shale, succeeding black shales and distinctly limited at the top by shales of a like bituminous character. In the Naples valley it is also distinctly differentiated from the shale below and above it, but is decidedly more arenaceous, containing at two horizons bands of sandstones and frequent flags. There is also interstratified in the upper part a thin stratum of limestone of a peculiar character and known as the Parrish limestone that may be easily traced with the black

Rhinestreet shale, that everywhere in the western part of the State caps the Cashaqua shale, into the Keuka lake valley in the southern part of which the limestone reaches its greatest development so far as it is exposed, but the black band of Rhinestreet shale is reduced in thickness to about 10 feet and the light shales intervening between it and the limestone are also very much diminished.

The Parrish limestone is recognizable in Big Stream ravine with the Rhinestreet shale 10 inches thick overlying it, the intervening shales having thinned entirely out.

The only exposure of their horizon on this quadrangle on the west side of the lake is on Plum creek half a mile above Himrods. Neither limestone nor black shale appears here but a band of calcareous olive shale containing many fossils indicates their place in the strata.

The proportion of sandy sediment in the Cashaqua beds is much greater in the upper part and increases toward the east and south to such an extent that only the lower beds conform strictly to the description of the Cashaqua shale as it appears in Cashaqua creek while the upper contains many flags and thick layers of hard blue gray sandstone some of which split into even flags while others are compact.

Exposures at Starkey and North Hector show that with the incoming of the sandy sediments a gradual change in the fauna appeared, brachiopods which are not found in these beds in the Naples valley or farther west occurring in thin calcareous layers, and masses of the coral Cladochonus about 100 feet above the base of the formation.

From this horizon upward through several hundred feet of shales and sandstones there are irregular alternations and combinations of the Naples and Ithaca faunas and toward the east a gradual segregation of the latter in the formation succeeding the Cashaqua. This formation is well exposed along Plum creek below and above Himrods, in the ravine and along the dugway roads east of Starkey, along the lake shore north of Glenora, and on the east side from the south line of the quadrangle to the north side of North Hector point, and in the ravines of Curry, Breakneck, Lodi, Tommy and Sixteen Falls creeks. The sandstones are exposed in old quarries in the western part of the village of Ovid and in the vicinity of Scott Corners. The Cashaqua shale is not a very fossiliferous formation but thin seams in which fossils are fairly common occur at all horizons.

Bactrites aciculum (Hall), Probeloceras lutheri Clarke, Pterochaenia fragilis (Hall) and Buchiola retrostriata (von Buch) occur in the lower beds and in the shaly layers throughout the formation. A thin calcareous seam in a sandstone 125 feet above the base of the formation exposed by th side of the dugway road ½ mile east of Starkey station contains:

Leptrostrophia mucronata (*Conrad*)
Spirifer mucronatus *Conrad var.* posterus *Hall & Clarke*
Sp. laevis *Hall*
Cladochonus
Crinoid stems

The higher sandstones on Breackneck creek at North Hector an(on Lodi creek contain in addition:

Ambocoelia umbonata *Hall*
Cyrtina *sp.*
Productella spinulicosta *Hall*
Chonetes lepidus *Hall*
Honcoyea major *Clarke*

and Liorhynchus quadricostatum Hall occurs in the sandstones at Ovid and several other species of brachiopods in the quarries in this horizon near the east line of the quadrangle.

Rhinestreet shale

In the region about the south end of Seneca lake and westward to Lake Erie this shale succeeds the Cashaqua shale with a thickness of 165 feet. It is represented on this quadrangle by 2 feet of black shale, in the ravine of Plum creek half a mile west of Himrods. It appears at the Big Stream ravine at Glenora, but is not recognized on the east side of the lake on these quadrangles. It is a well defined feature in the stratigraphy of western New York and is more fully described in Museum bulletins 63, 81 and 101.

Hatch shale and flags

This formation is the stratigraphic equivalent of the lower Gardeau beds in the Genesee river section and consists of a series of shales and sandstones aggregating about 350 feet in thickness.

The shales range from black to light blue and from hard sandy or slaty to soft and blocky, and there are frequent layers of hard blue sandstone from 2 inches to 2 feet in thickness occurring at irregular intervals, some of which are continuous for long distances without change of character or thickness, while others thin out or become shaly and disappear in a few rods. The lower beds of this formation are much softer than the upper Cashaqua beds and in

some parts bear a close resemblance to the olive and blue shales of the lower beds of that formation.

The increase in the proportion of sand in the sedimentation toward the east so noticeable in the upper beds of the Cashaqua is also apparent in this formation though to a less degree.

The gradual change in the character of the fauna in that direction is, however, still more marked.

In the Genesee river section no fossils but those of the normal Portage or Naples fauna are found in these beds. At Naples near the top a thin seam shows remains of brachiopods broken and crushed beyond recognition but they do not occur below that horizon, while in this region vertical sections show frequent alterations of the normal Naples fauna and the brachiopodous Ithaca fauna of central New York; indication of oscillation between them in which the latter acquires predominance in the Cayuga lake valley but not to the exclusion of the former.

Although this formation covers a large area on this quadrangle there are few satisfactory exposures and none that are favorable for an exhaustive collection of its fossils.

The following species have been obtained from the Hatch shale and flags in the Seneca lake valley, mainly from the region south of this quadrangle:

Manticoceras patersoni (*Hall*)
Probeloceras lutheri *Clarke*
Tornoceras uniangulare (*Conrad*)
Orthoceras bebryx *Hall*
Bactrites
Styliolina fissurella *Hall*
Bellerophon koeneni *Clarke*
Loxonema noe *Clarke*
Spirifer laevis *Hall*
Sp. mucronatus *var.* posterus *Hall & Clarke*
Sp. subumbona *Hall*
Productella speciosa *Hall*
Schizophoria impressa (*Hall*)
Atrypa reticularis *Linné*
Centronella julia *A. Winchell*
Chonetes scitulus *Hall*
C. lepidus *Hall*
Productella spinulicosta *Hall*
Strophalosia truncata *Hall*
Leptostrophia mucronata (*Vanuxem*)
Buchiola retrostriata (*v. Buch*)
Lingula spatulata *Vanuxem*
Pterochaenia fragilis (*Hall*)
Paracardium doris *Hall*
Lunulicardium ornatum *Hall*
Honeoyea erinacea *Clarke*
Paleoneilo *sp.*
Cladochonus

Grimes sandstone

This is a well defined arenaceous band easily recognized in the region west of these quadrangles as far as the Genesee river. It is made distinctive in the Naples and Dansville valleys by containing the lowest brachiopod faunule in the Portage section of that region.

Data for its location on this map are derived principally from field work on the quadrangles at the south and west of this one, the few exposures here not being sufficient for its positive identification.

Its position is approximately indicated on the map and its assigned thickness is 75 feet.

West Hill (Gardeau) flags and shale

Except that the proportion of sandstones in the shales is somewhat greater and more uniformly distributed there is very little difference between the stratification of this formation and the West Hill beds below. They are, however, less fossiliferous. A few representatives of the Ithaca fauna are found in all parts as are also a small number of species common in the Naples fauna.

Soft gray shales resembling the Cashaqua shale, exposed on Butcher hill, in the upper part of this formation, contain obscure goniatites, orthoceratites and Cladochonus, but no brachiopods.

High Point sandstone

This formation is important stratigraphically and economically in the Genesee river section. There it contains only fossils of the Portage fauna but is stratigraphically continuous with the High Point sandstones of the Naples section where it contains mainly brachiopods common in the Chemung fauna. It becomes shaly in some parts toward the east but can be traced at least as far as the region south of these quadrangles. There are here but small isolated exposures of its horizon in small ravines on the higher slopes of Butcher hill.

Prattsburg sandstone-Wiscoy shale Chemung sandstone

The position of these formations at the crest of the high ridge between the Seneca lake and Cayuga lake valleys where there are no favorable exposures is indicated from data obtained on the Watkins quadrangle. For description of these higher beds and lists of fossils contained in them see Museum bulletins 63, 81 and 101.

DIP

The average dip of the rock strata on these quadrangles is approximately 24 feet per mile toward the south and toward the west, the latter dip being caused mainly by the decrease in that

direction of the thickness of nearly all of the formations represented on the map. The amount of dip between different points is greatly affected, however, by the presence of a series of undulations or low anticlinal folds that render it exceedingly variable and in many cases reverse it.

The color line on the map that indicates the position of the Tully limestone shows the irregularity of the dip in the direction of the shores of the lake and the larger undulation of the strata, to which attention has been directed in the description of that formation.

Variations in the western dip are less noticeable to the casual observer on account of their less favorable exposure in rugged and sinuous ravines away from the level lake which on the shore makes the smallest variation from the normal southern dip easily discernible.

Most of the larger ravines on both sides of the valley show a dip toward the lake, indicating that the location of the depression now partly occupied by the waters of Seneca lake was primarily determined by a synclinal fold of the rock strata extending in the same general direction as the present valley that was very greatly enlarged and deepened by subsequent erosion.

At the following localities on the west side of the lake an eastward dip is seen, at the falls of Wilson creek near the west line of the quadrangle and 3½ miles south of Geneva it is 100 to 150 feet per mile; on Kashong creek the Tully limestone at the top of the falls dips toward the northeast at the rate of more than 100 feet per mile. On the Keuka outlet a sharp fold in the Tully limestone extending from northeast to southwest, has produced what is almost equivalent to a fault.

The Tully limestone appears in the top of a conical hill 1¼ miles southwest from Dresden at 565 A. T. and again at about the same level at the mouth of Bruce gully. It is exposed along up the south side of the gorge to the Cascade mills where it produces a cascade. The bottom and sides of the gorge are covered for nearly a mile west to Seneca mills where the Tully reappears at the top of a second cascade 40 feet higher than at the Cascade mills. This curious phenomenon of a stream of water flowing over the same stratum of rock at two different levels is duplicated in the Great gully ravine 2½ miles south of Union Springs, where a hard band of calcareous shale produces three cascades in a similar manner. The situation is very similar except that but one fall occurs in the Bruce gully where the limestone is exposed in the

bank 10 rods from the mouth at 550 A. T. It is covered for some distance up the ravine but occasional outcrops of the Moscow shale show that it is nearly level to about 25 rods from the mouth above which the strata rise rapidly toward the south and west for 35 rods and then are nearly level for 15 rods to the falls where the limestone crosses the ravine at 595 A. T. or 45 feet higher than at the mouth.

An exposure of Hamilton shale on the south side of Keuka outlet half a mile above Dresden shows a strong dip toward the lake.

Exposures in the south side of Perry point show a northeast dip and the top of the Tully limestone is 120 feet higher in the Perry point ravine than at a point directly east on the opposite side of the lake.

The apex of a fold crosses diagonally the ravine of Plum creek ¾ mile from the lake. On the east side of the fold the strata descend toward the east at the rate of 150 feet or more per mile. On the west side there is a slight western dip for about half a mile when it is again reversed and is quite strong toward the lake. At the Severn arch the top of the Tully is 45 feet above the lake level but on the opposite side it is below it, showing an eastward dip of 20 feet or more per mile.

At the south end of the lake the strata on the east side are about 25 feet lower than on the west. Exposures are not favorable to the measurement of dip on the east side in the southern part of the quadrangle, but in the Lodi glen the Tully limestone shows a western dip of 150 feet per mile, and the other ravines in this vicinity show that this steep dip toward the lake continues for at least 8 miles and that some of the apparent undulations of the limestones are caused by sinuosities in the line of outcrop. A western dip of more than 200 feet per mile is noticeable in the quarries and roadside exposures in the western part of the village of Ovid.

On the east side of the ridge the eastward dip toward Cayuga lake is shown in the ravines east of Hayt Corners and in the Big Hollow creek and other ravines farther north. On the opposite side of the lake conditions are much like those on Seneca lake, the western dip being increased to many times the average.

The diagram accompanying the map is designed to show highly exaggerated the variations in the dip along the east and west line of 42° 40′ across the Ovid and Genoa quadrangles, a distance of 26 miles.

Glacial striae may be seen on the exposed surface of the Tully limestone at many places and also on the higher sandstones. Much of the flagging about the village of North Hector is finely striated and a most remarkable display of groovings and striations may be seen on the surface of the flag walk 80 feet long by 6 feet wide in front of the hotel at North Hector point.

The flags are from the upper Cashaqua beds and are the surface layers in a quarry a mile north of North Hector.

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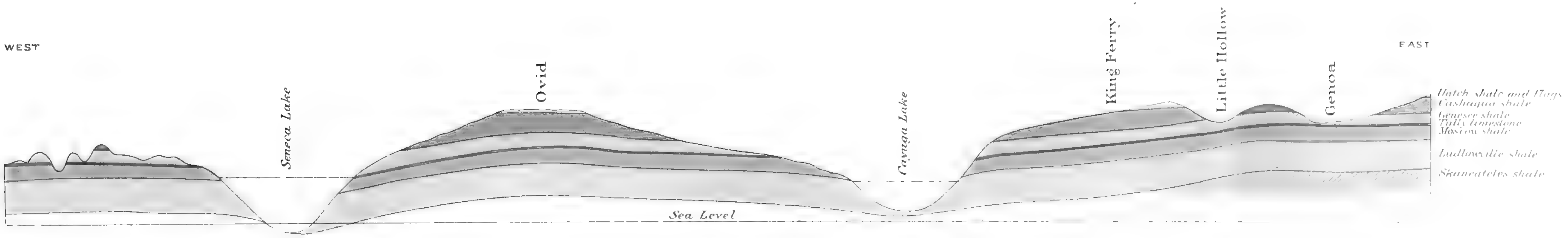
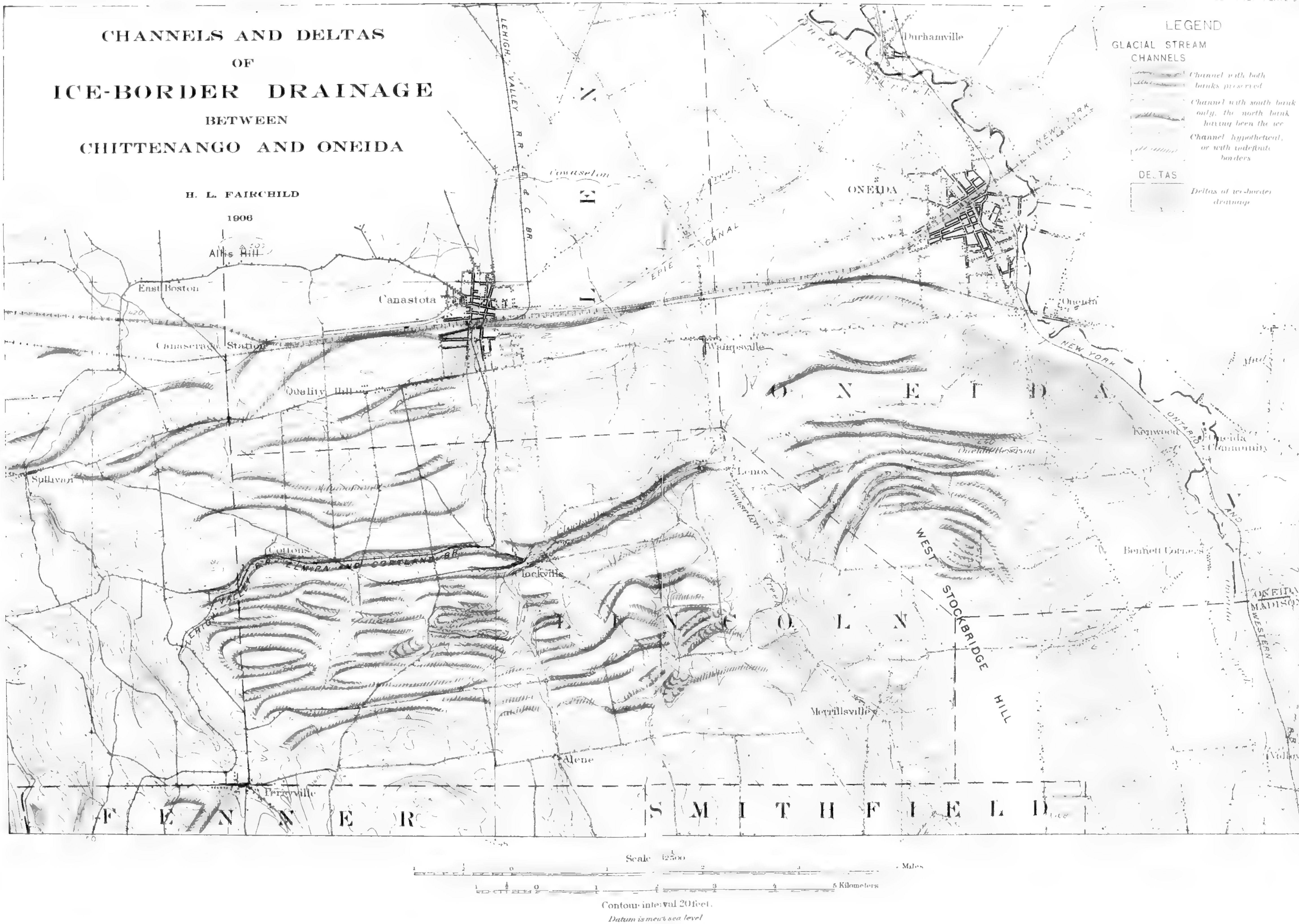


EAST-WEST SECTION ON OVID AND GENOA QUADRANGLES AT LINE OF 42° 40′ N SHOWING THE LOW SYNCLINES OF THE LAKE BASINS

VERTICLE SCALE 1 INCH = 1000 FEET
HORIZONTAL " 1 " = 2 MILES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Channel with south bank only, the north bank having been the ice
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Merrillsville
Alene
Perryville
Valley
WEST STOCKBRIDGE HILL
O N E I D A
L I N C O L N
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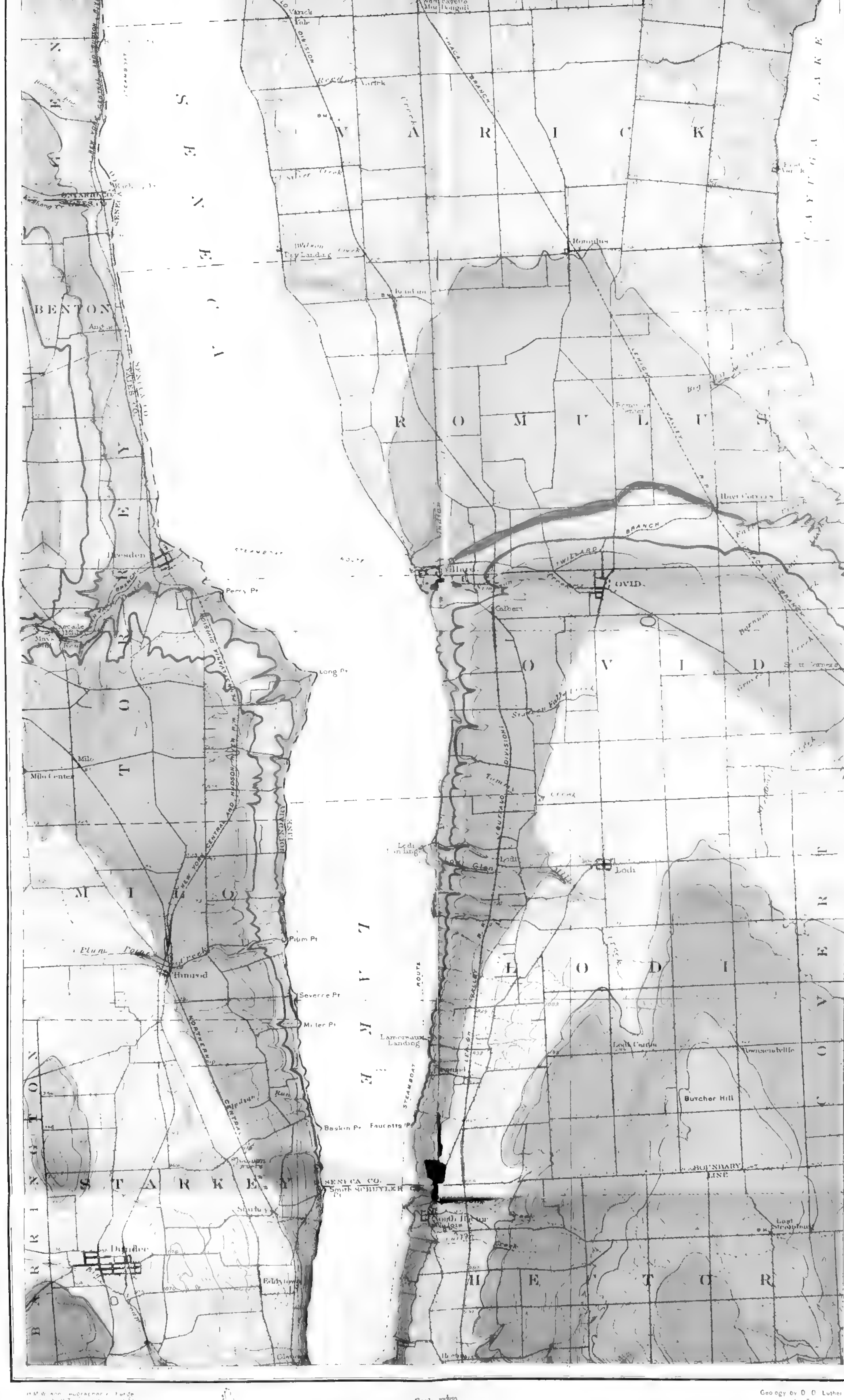
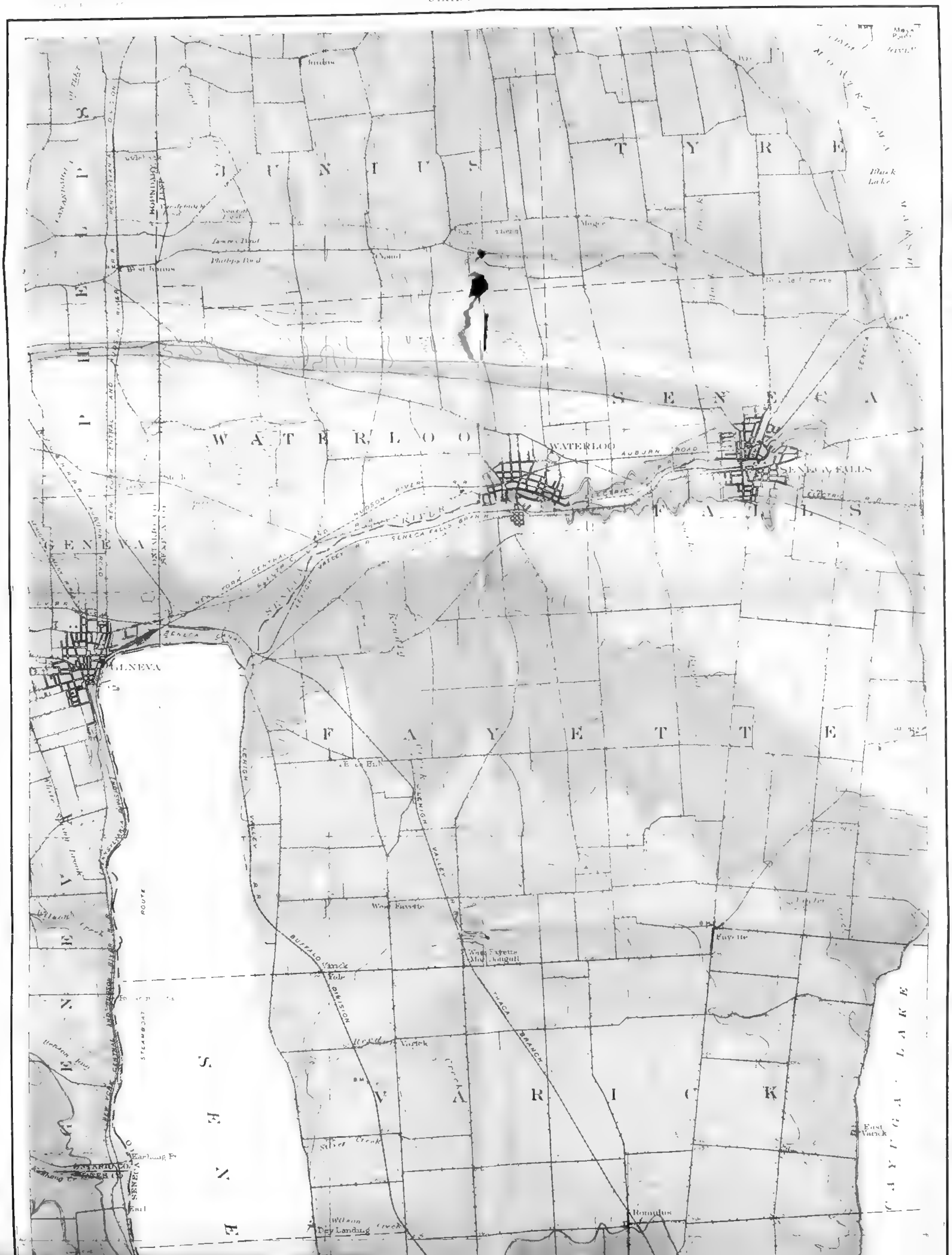
S M I T H F I E L D
ONEIDA
MADISON
ERIE CANAL
NEW YORK
ONTARIO AND WESTERN
ELMIRA AND CORTLAND BR.
LEHIGH VALLEY R.R.
Scale 1/62500
Miles
Kilometers
Contour interval 20 feet.
Datum is mean sea level



Geology by D. D. Luther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UNIVERSITY OF THE STATE OF NEW YORK
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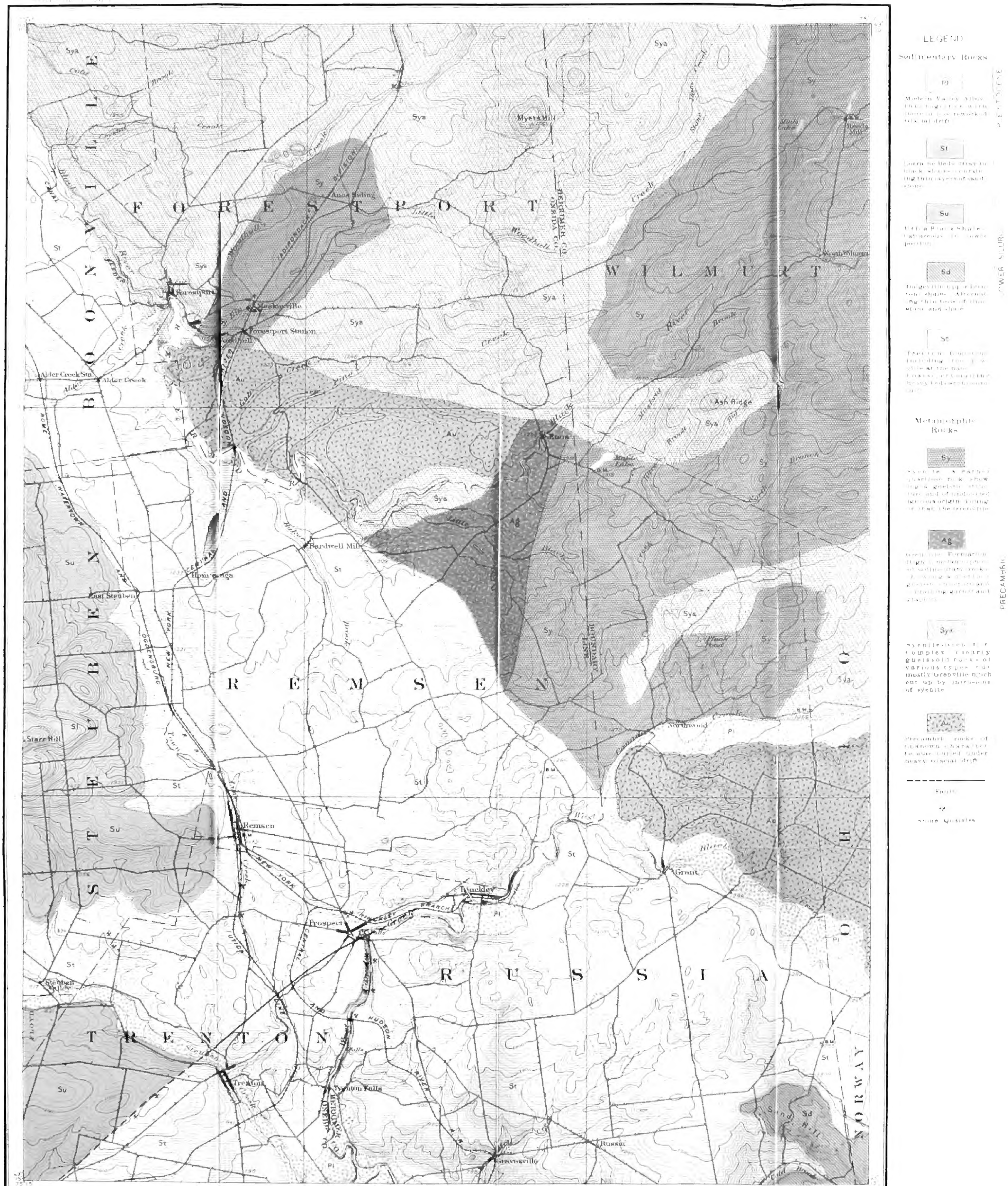

Geology by W. J. Miller
1907

Scale 1/62500

Contour interval 20 feet

MUSEUM BULLETIN 126

Geologic map of the Remsen quadrangle

MUSEUM BULLETIN 127

Glacial Waters in Central New York

Plate 3 Channels and deltas of ice-border drainage between Irondequoit and Cayuga valleys

Plate 4 Channels and deltas of ice-border drainage between Jordan and Chittenango valleys

Plate 5 Channels and deltas of ice-border drainage between Chittenango and Oneida valleys

MUSEUM BULLETIN 128

Geologic map of the Geneva-Ovid quadrangles